The Analysis and Design of an Ergonomic Training Course for Microscope Users at Calgary Laboratory Services

Thomas Jared Coffyne

A Master's Degree Project submitted to the Faculty of Environmental Design in partial fulfillment of the requirements for the degree of Master of Environmental Design

Calgary, Alberta
September 2002

© Thomas Jared Coffyne 2002
The author of this thesis has granted the University of Calgary a non-exclusive license to reproduce and distribute copies of this thesis to users of the University of Calgary Archives.

Copyright remains with the author.

Theses and dissertations available in the University of Calgary Institutional Repository are solely for the purpose of private study and research. They may not be copied or reproduced, except as permitted by copyright laws, without written authority of the copyright owner. Any commercial use or re-publication is strictly prohibited.

The original Partial Copyright License attesting to these terms and signed by the author of this thesis may be found in the original print version of the thesis, held by the University of Calgary Archives.

Please contact the University of Calgary Archives for further information:
E-mail: uarc@ucalgary.ca
Telephone: (403) 220-7271
Website: http://archives.ucalgary.ca
Acknowledgements

First, I would like to acknowledge my supervisor Ron Wardell for his advice and insights into my project, without which none of this would have been possible. I would also like to thank him for his patience over the extended period of time that I needed to perform this work.

Second, I would like to thank Linda Miller who taught me a great deal about the process of working with clients. With her help I now feel comfortable applying the skills I have gained in school and in work to virtually any situation.

Third, I would like to thank Calgary Laboratory Services and specifically Carol Becker. The support given to graduate students over the past years is appreciated more than they can know.

Finally, I would like to thank my wife Shauna, sister Heather and Father Blaine who have supported me in more ways than I can count during this project and in life.
Abstract

The Analysis and Design of an Ergonomic Training Course for Microscope Users at Calgary Laboratory Services
Thomas Jared Coffyne
Supervisor: Ron Wardell
September 2002

Prepared in partial fulfillment of the requirements of the Master's of Environmental Design Degree in the Faculty of Environmental Design, The University of Calgary

This project addressed the analysis of ergonomic issues for microscope users at Calgary Laboratory Services and the process of developing an ergonomic training course for those users. First the seven theoretical elements of training course design were determined, which included: determining if training is necessary, identifying training needs, identifying goals and objectives, developing learning activities, conducting training, evaluating the program effectiveness and improving the program. These seven elements were applied as action items to the development of an ergonomic training course for microscope users at Calgary Laboratory Services. By applying the theoretical training elements in a real world situation difficulties concerning the application of training theory in this instance and recommendations to improve the process of applying theory when working with clients was discovered. Difficulties encountered during this project included: use of a formal strategy to select a control, lack of a management/staff supervisory committee and ensuring evaluation is a key element in training course design. In each instance when difficulties were encountered they were addressed in a manner that ensured the quality of the course was not negatively affected. The cumulative effect of these finesse judgments is further discussed in the concluding chapter. It was determined that the cumulative effect of these decisions had no measurable negative impact on the mission statement of the training course. This is followed by recommendations to improve the process of training course design included using the stages of training course design as
closely as possible, building evaluation into the process of training course design, gaining support from key players within the organization. The recommendation of using all stages of training course design was made as it was discovered that any deviation from the recognized process might create difficulties for the course designer at later stages in development of the course. Building evaluation into the process of course design was recommended to ensure that continual improvement is built into the process of the training course design, allowing the training course to adapt to the needs of the trainees. Finally gaining support from key players was recommended, as this is not an element in training course design theory. Many courses may fail without appropriate support within an organization. The process of gaining support should be included as early as possible in the training course design process. It is hoped that this project provided Calgary Laboratory Services with an effective tool to combat musculoskeletal injuries amongst microscope users and it is also hoped the recommendations can be used to improve the process of training course design.

Key Words: musculoskeletal injury (MSI), ergonomics, training course design, microscope users, microscopists, ergonomic training course, training programs.
# Table of Contents

## Chapter One - Ergonomic Training Courses

1. **Introduction to Ergonomics**  
   - 1.1 Introduction to Ergonomics  
   - 1.2 Purpose and Scope of the Study  
   - 1.3 Calgary Laboratory Services Background Information  
     - 1.3.1 Calgary Laboratory Services Background  
     - 1.3.2 Ergonomic Concerns at Calgary Laboratory Services  
       - 1.3.2.1 What is Musculoskeletal Injury?  
   - 1.4 Process used to Develop the Ergonomic Training Course  
     - 1.4.1 Determining if Training is Necessary  
     - 1.4.2 Identifying Training Needs  
     - 1.4.3 Identifying the Goals and Objectives  
     - 1.4.4 Developing Learner Activities  
     - 1.4.5 Conducting the Training  
     - 1.4.6 Evaluating Effectiveness and Improving the Program  
   - 1.5 Chapter Summary  
     - 1.5.1 Review  
     - 1.5.2 Conclusions

## Chapter Two - Determining if Training is Necessary

2. **Literature Review**  
   - 2.1.1 Types of Controls  
     - 2.1.1.1 Engineering Controls  
     - 2.1.1.2 Administrative Controls  
     - 2.1.1.3 Training  
   - 2.1.2 Choice of Controls  
   - 2.2 Calgary Laboratory Services  
     - 2.2.1 Trigger  
     - 2.2.2 Decision over Type of Control  
       - 2.2.2.1 Gaining Support  
   - 2.3 Chapter Summary
Chapter Three - Needs Assessment

3.1 Literature Review

3.1.1 Hazard Assessment
3.1.2 Population Profile
3.1.3 Social Context
  3.1.3.1 Manager - Employee Cooperation

3.2 Calgary Laboratory Services

3.2.1 Hazard Assessment at CLS
  3.2.1.1 Task Analysis
  3.2.1.2 Literature Review

3.2.2 Population Profile
  3.2.2.1 Survey
  3.2.2.2 Interviews
  3.2.2.3 Population Summary

3.2.3 Social Context
  3.2.3.1 Employee - Management Cooperation

3.3 Chapter Summary

3.3.1 Review
3.3.2 Conclusions

Chapter Four - Objectives and Goals

4.1 Literature Review

4.1.1 Specific Goals or Objectives
4.1.2 Types of Objectives
  4.1.2.1 Information Objectives
  4.1.2.2 Attitude Objectives
  4.1.2.3 Skill Achievement Objectives
  4.1.2.4 Behavior Objectives
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2 Calgary Laboratory Services</td>
<td></td>
</tr>
<tr>
<td>4.2.1 Mission Statement</td>
<td>75</td>
</tr>
<tr>
<td>4.2.2 Objectives</td>
<td>77</td>
</tr>
<tr>
<td>4.2.2.1 Ergonomic Background Material</td>
<td>77</td>
</tr>
<tr>
<td>4.2.2.2 General Risk Factors</td>
<td>78</td>
</tr>
<tr>
<td>4.2.2.3 Microscope Use Hazards</td>
<td>79</td>
</tr>
<tr>
<td>4.2.2.4 Workstation Adjustment</td>
<td>80</td>
</tr>
<tr>
<td>4.2.2.5 Behavior Changes</td>
<td>81</td>
</tr>
<tr>
<td>4.2.2.6 Resources Available</td>
<td>82</td>
</tr>
<tr>
<td>4.2.3 Assumption of Instructional Model</td>
<td>83</td>
</tr>
<tr>
<td>4.2.4 Management Staff Cooperation</td>
<td>85</td>
</tr>
<tr>
<td>4.3 Chapter Summary</td>
<td>89</td>
</tr>
<tr>
<td>4.3.1 Review</td>
<td>89</td>
</tr>
<tr>
<td>4.3.2 Conclusions</td>
<td>90</td>
</tr>
<tr>
<td>Chapter Five - Developing the Learning Activities</td>
<td>94</td>
</tr>
<tr>
<td>5.1 Literature Review</td>
<td>94</td>
</tr>
<tr>
<td>5.1.1 Contents of the Training Course</td>
<td>95</td>
</tr>
<tr>
<td>5.1.1.1 General Awareness Training</td>
<td>97</td>
</tr>
<tr>
<td>5.1.1.2 Job-Specific Training</td>
<td>97</td>
</tr>
<tr>
<td>5.1.2 Ensuring Training is Successful</td>
<td>98</td>
</tr>
<tr>
<td>5.1.2.1 Importance of Training</td>
<td>98</td>
</tr>
<tr>
<td>5.1.2.2 Involvement in Training</td>
<td>98</td>
</tr>
<tr>
<td>5.1.3 Training Techniques</td>
<td>99</td>
</tr>
<tr>
<td>5.1.4 Resources of the Organization</td>
<td>100</td>
</tr>
<tr>
<td>5.2 Calgary Laboratory Services</td>
<td>101</td>
</tr>
<tr>
<td>5.2.1 Type of Training</td>
<td>102</td>
</tr>
<tr>
<td>5.2.2 Techniques Selected for Training</td>
<td>103</td>
</tr>
<tr>
<td>5.2.2.1 Lecture</td>
<td>103</td>
</tr>
<tr>
<td>5.2.2.2 Discussion</td>
<td>104</td>
</tr>
<tr>
<td>5.2.2.3 Tutorial/Student Activity</td>
<td>105</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>7.1.2</td>
<td>Using Evaluative Techniques</td>
</tr>
<tr>
<td>7.1.3</td>
<td>Other Uses for the Evaluation of Training Courses</td>
</tr>
<tr>
<td>7.1.4</td>
<td>When not to Evaluate Training Programs</td>
</tr>
<tr>
<td>7.1.5</td>
<td>Improving the Training Program</td>
</tr>
<tr>
<td>7.2</td>
<td>Calgary Laboratory Services</td>
</tr>
<tr>
<td>7.2.1</td>
<td>Learning Recommendations</td>
</tr>
<tr>
<td>7.2.2</td>
<td>Behavior Recommendations</td>
</tr>
<tr>
<td>7.2.3</td>
<td>Results Recommendations</td>
</tr>
<tr>
<td>7.2.4</td>
<td>Choosing Evaluation Methods</td>
</tr>
<tr>
<td>7.3</td>
<td>Chapter Summary</td>
</tr>
<tr>
<td>7.3.1</td>
<td>Review</td>
</tr>
<tr>
<td>7.3.2</td>
<td>Conclusions</td>
</tr>
<tr>
<td>8.1</td>
<td>Project Overview</td>
</tr>
<tr>
<td>8.2</td>
<td>Calgary Laboratory Services</td>
</tr>
<tr>
<td>8.2.1</td>
<td>CLS Conclusions</td>
</tr>
<tr>
<td>8.3</td>
<td>Recommendations</td>
</tr>
<tr>
<td>8.3.1</td>
<td>Use all Stages of Training Course Design</td>
</tr>
<tr>
<td>8.3.2</td>
<td>Building Evaluation into the Process</td>
</tr>
<tr>
<td>8.3.3</td>
<td>Gaining Support from Key Players</td>
</tr>
<tr>
<td>8.4</td>
<td>Chapter Summary</td>
</tr>
<tr>
<td></td>
<td>Chapter Nine - References</td>
</tr>
</tbody>
</table>
Appendix 1  702 Consent Form
Appendix 2  702 Task Analysis Checklist
Appendix 3  Ergonomic Training Course Questionnaire
Appendix 4  Interview Consent and Information Forms
Appendix 5  Ergonomic Training Course Consent Forms
Appendix 6  Employee Ergonomic Resource Manual
Appendix 7  Ergonomic Training Course with Speakers Notes
Appendix 8  Evaluation Forms

List of Tables

Table 3.1 - Frequency of discomfort by body part  56
Table 3.2 - Percent of respondents reporting discomfort by work group  57
Table 3.3 - Microscope users perceptions of musculoskeletal discomfort  59
Table 6.2 - Evaluation form results from initial training course  123

List of Figures

Figure 3.1 - Multi-user microscope station at CLS  46
Figure 3.1 - Individual microscope workstation at CLS  47
Figure 3.3 - Commercially available pivoting armrests at workstation  49
Figure 3.4 - User designed armrests at workstation  49
Figure 3.5 - Ranges of adjustment required at seated workstations  52
Figure 6.1 - Possible matrix for structures group feedback  118
Figure 7.1 - Information gathered and comparative costs of evaluations  137
Chapter One - Ergonomic Training Courses

In this chapter of the document there will be a brief introduction to the field of ergonomics. During this introduction the elements of an ergonomic program will also be discussed. In the second section of the introduction the purpose and scope of this Masters Degree Project (MDP) will be specified. In the following section a general background of the client, Calgary Laboratory Services (CLS), will be given and the major ergonomic concerns of CLS will also be discussed. In the last section of the introductory chapter the process that was used to develop the ergonomic training course will be explained and the organization of the rest of the paper will be outlined.

1.1 Introduction to Ergonomics

Ergonomics is a discipline that is broad encompassing many different fields of study. Therefore it is not surprising that there can be a great deal of disagreement among professionals who work in the field, concerning a definition of ergonomics. Some define ergonomics as "the science of designing the work environment to fit the capabilities of workers"\(^1\). For the purposes of this paper Ergonomics will be defined as, "the study of the interaction between human beings and objects they use and the environments in which they function"\(^2\). This is a more broad definition allowing more latitude in the interventions that can be used.
With so much disagreement over the definition of ergonomics it again is not surprising that there can also be disagreement over the objective of an ergonomic intervention. For the purposes of this project a global view of the objectives of any ergonomic intervention will be used. This view is consistent with the view of Alexander and Pulat (1985) who state that the major objectives of any ergonomic intervention are the "improved well-being, comfort and efficiency for the worker". When the objectives of an ergonomic intervention are successfully met in a work place, the workers may enjoy increased job satisfaction, reduced musculoskeletal injury and increased productivity. By using a global view of ergonomics one is able to select what type of impact the ergonomic intervention is meant to have on an organization.

Ergonomics in the past has often focused on a single control to impact the worker. These controls would be implemented with little thought to how the project might impact other areas of the organization. For example the resources to produce the control might have had greater impact on the workers or organization by using the resources in another area of the organization. These types of projects may have been more successful if the projects would have been implemented within a framework that looked to apply ergonomics across the entire organization.

Today this is just what is happening. There is now an increased emphasis on a holistic application of ergonomics within organizations. Agencies such as the
State of Washington, the Occupational Safety and Health Administration and the Provinces of British Columbia and Alberta have all produced guidelines for the implementation of ergonomics programs within various industries. These agencies look to give companies a general outline that can be used to implement an ergonomics program that will improve the well-being, comfort and safety of the worker.

A review of Fitting the Job to the Worker: an ergonomic program guideline, produced by the State of Washington; and a review of Ergonomics Program Management Guidelines for Meatpacking Plants, produced by the Occupational Safety and Health Administration identifies four common components of an ergonomics program. These four common program elements used by these two organizations are:

- Worksite Analysis.
- Hazard Prevention and Control.
- Medical Management.
- Training and Education.

These are by no means a complete representation of all the elements of an ergonomics program. They are the broad categories under which an ergonomics program could be developed in a number of different industries.
1.2 Purpose and Scope of the Study

When discussing the purpose and scope of this MDP it is easy to consider the microscope users and the CLS administration as the end users of this training course. However, if the training course impacts the technicians that perform the testing procedures then the general public and patients for whom the tests are being performed need to be considered. If the technicians generate increased numbers of false results, negative or positive, the course obviously impacts the public waiting for their medical tests. As a result, the design of the course must ensure that false results are not increased and preferably are decreased. If the course were to increase false results it would be very unlikely that other benefits of the training course would outweigh the serious consequences of increasing reports of false tests. This topic of the patient being the end user, and how those users will be impacted by this training course, will be readdressed in Chapter Eight the concluding section.

The purpose of this project was to address the analysis of ergonomic issues for microscope users at Calgary Laboratory Services and the process of developing an ergonomic training course for those users. By implementing this training course it is hoped that the microscope users at CLS will feel a positive impact through improved well-being and health in the workplace. Through these positive outcomes it is also hoped that CLS will experience positive impacts through reduced medical costs and increased employee efficiency.
The scope of the training course design project is to apply the theoretical elements of training course design as action items up to and including the reactive evaluation of a pilot course. By taking the theoretical elements of training course design and applying them to a real world environment it is hoped some of the difficulties training course designers encounter when applying theoretical knowledge to real world situation can be discovered. By identifying the difficulties that are encountered when applying theoretical constructs to a real situation, it is hoped that further training course design in this area will be improved. The end product of this MDP will be a training course that can be used at CLS to improve employee skills and awareness relating to ergonomic issues within the workplace. It will also assist other training course designers when developing ergonomic training by demonstrating how theoretical knowledge can be used to develop a course and the difficulties that may be encountered while developing a course.

Readers will note that this MDP addresses the problems of microscope users from a health and safety perspective when there are other manners to address ergonomic concerns. The health and safety slant was selected, as the true client of the MDP is the Environmental Health and Safety Department at CLS and it is easier to interact with the client when working from the same background.
1.3 Calgary Laboratory Services Background Information

In this section a brief background of CLS is given. This will be followed by the description of the ergonomic concerns of using a microscope at CLS. By having this information the reader will better understand some of the decisions made during the design of this ergonomic training course.

1.3.1 Calgary Laboratory Services Background

CLS is a laboratory testing facility in Calgary, Alberta, Canada. The company is a partnership between the Calgary Health Regional and private industry. The company employs a large number of microscopists, in excess of 300, who perform microscope work and other medical testing procedures as a part of their daily work duties.

CLS is divided into a number of different departments. These departments include Cytology, Microbiology, Hematology, Anatomical Pathology and Urinalysis. The majority of microscope users belong to one of these five departments although there may be some users such as residents that do not fall under these departmental classifications. The amount of microscope use varies quite significantly depending on the department the user is from. This usage pattern is further outlined in the results section of this document.

Microscope users who work for CLS are spread throughout the city in a number of different facilities. The majority of users are concentrated in the Central Lab
located in downtown Calgary. The rest of the users are spread throughout the hospitals in Calgary and in small branch labs spread throughout the city. The differences in microscope use by department and by geographical location makes developing a training course for use by all departments in all locations a difficult endeavor.

1.3.2 Ergonomic Concerns at Calgary Laboratory Services

CLS employs a large number of microscope users who work at microscope workstations for up to seven hours per day. The American Society of Cytopathology reports that 70.5% of Washington cytotechnologists report some form of shoulder, neck or upper back problems\(^6\). Ninety one percent of those reporting symptoms have at least one symptom, and 30.8% have at least four symptoms. Another study reports that 84% of microscopists in Stockholm's county hospital laboratories suffer from job related musculoskeletal pain\(^7\). Many other studies report similar findings on the occupational hazards associated with microscope work. These figures demonstrate that microscopists experience alarmingly high rates of musculoskeletal discomfort and injury.

The negative effects of spending long periods of time in static and awkward postures are compounded when options for individual adjustment of the workstation are limited\(^8\). The negative short-term effects that result from the use of these workstations include reduced comfort and reduced efficiency. Long-term detriments to employee health are often referred to as musculoskeletal injuries. These short term and long term effects impact workers negatively and
may negatively affect CLS through reduced efficiency, worker dissatisfaction and increased costs due to medical claims and lost time from injuries.

1.3.2.1 What is Musculoskeletal Injury?

It may be necessary at this point to specify what is meant by the term musculoskeletal injury. The term refers to a wide range of conditions affecting the physical systems in the body, which allow the body to change and maintain postures. This complex system includes the structures of tendons, muscles, bone, ligaments, blood vessels, and nerves. These structures can be injured, or their function impaired, by either acute trauma or chronic overloading of their capacity. Even though injury is localized within a specific structure, the cause of the injury is multifaceted.

Musculoskeletal injury is not limited to the work environment. Both acute and chronic conditions are seen in sports and other lifestyle activities. However, in a review of more than 600 scientific papers by the U.S. National Institute for Occupational Safety and Health, considerable evidence for a causal relationship between factors in the work environment and musculoskeletal injury was demonstrated. The incidence of musculoskeletal injury in the working population is considerably higher than in the general population and specific occupational groups experience higher rates than the working population as a whole.
In the laboratory environment the most common types of injuries are those resulting from the effects of chronic overloading, which are more commonly known as overuse injuries. There are a number of different terms used for this group of conditions:

- Work-related musculoskeletal disorders (WMSDs)
- Repetitive strain injuries (RSI)
- Cumulative trauma disorders (CTDs)

All of these terms are used to group a wide range of medical conditions including tendonitis, tendosynovitis, bursitis, carpal tunnel syndrome, thoracic outlet syndrome, and general neck and back pain.

Although the causes of overuse injuries have not been clearly demonstrated, the most prevalent view is that these conditions arise as a result of cumulative micro trauma and primarily affect the soft body tissues. Micro trauma results from overuse and insufficient time for rest and repair of damaged tissue, and eventually leads to inflammation, edema, ischemia, tearing, fibrosis, and vascular and nerve compression. Early symptoms can include mild pain, aching and fatigue, which disappear after sufficient rest. If the condition is left untreated, and causal factors are not reduced, the symptoms will increase in severity, duration, and will be experienced in multiple regions of the body. People in the laboratory environment typically experience a multiple site pattern of symptoms (i.e. pain in wrist, shoulder and neck). This is indicative of the direct effect of physical
demands on these various areas of the body, but also on the compensatory
effect, that is when the body attempts to reduce stress on one area, by over
activating another. Workplace risk factors for overuse injuries in the laboratory
setting include repetitive activity, in addition to prolong periods of awkward and
static postures\textsuperscript{14}.

1.4 Process used to Develop the Ergonomic Training Course

The purpose of this section is to outline the process for developing the training
course for CLS. These steps will become the chapters in this MDP document.

The seven steps or actions in this MDP are very similar to the steps that are
recognized as being essential for developing successful training as identified by
a review of the occupational safety and health training literature\textsuperscript{15}, which are:

1. Needs Assessment
2. Establishing training objectives
3. Specifying training content and media
4. Accounting for individual differences
5. Specifying learning activities
6. Evaluating Learning conditions
7. Revising the training.

The seven steps used in this document are the same steps that the Occupational
Safety and Health Administration (OSHA) lists as the stages to be used when
developing training programs in the workplace. The decision to use these steps as the theoretical background for this project is the result of a general agreement in the field of literature pertaining to training course design. It is also because I felt the step of "accounting for individual differences" is an issue that is considered when developing learning activities and should not require its own stage of course development. As a result, it is thought that the OSHA stages for training course design are a more complete manner of developing training than those stages identified in the previously listed literature review. They are more complete because they include a stage where it is determined whether training is in fact necessary.

This document combines the theoretical stages of Evaluating Training and Improving the Program into a single chapter due to the close relationship to one another. This will allow the reader to more directly view how training course evaluation can result in improvements to the course. As a result the seven steps and six core chapters in this MDP are as follows:

1. Determining if Training is Necessary
2. Identifying Training Needs
3. Identifying Goals and Objectives
4. Developing Learning Activities
5. Conducting the Training
6. Evaluating the Program Effectiveness and Improving the Program.
In the rest of the introductory chapter a brief description of each step will be given, along with the value of using that step during the development of a training course. In each of the six chapters that make up the main body of this MDP, further descriptions of the theory will given and the actions necessary to perform the step will be specified. At the end of each chapter how the theoretical information was applied as an action item during the CLS training course development will also be discussed.

Each chapter summary will include two sections, a chapter review that summarizes the information in that chapter, and a conclusions section, which will detail information on difficulties discovered when applying theoretical training course steps to the design of the training course at CLS.

### 1.4.1 Determining if Training is Necessary

The first critical element to developing a training program is determining whether training is necessary. Generally there is a problem that is at least partially identified that triggers an organization to determine if training is needed. The organization must then ask the question as to whether training is in fact the best solution for the problem that is being faced. In the case of CLS; will the ergonomic hazards associated with microscope use be better addressed through the use of engineering or administrative controls, or would training be the most effective way to control the hazards facing the worker?
Decisions are often based on how an organization can best spend its money to deal with a problem or hazard. Although costs for different interventions are often compared, it makes sense that the cost of the intervention versus the probable impact of the intervention that should be the deciding factor when determining what intervention is most appropriate. In essence a cost benefit analysis is performed, which will be discussed further in the next chapter. If this step in the development of the training course is not performed then a company or organization is at risk of wasting money and not using the most suitable method to control a hazard in their workplace.

1.4.2 Identifying Training Needs

If it is determined that training is in fact the most suitable intervention to address the hazards of the workplace then the next step is to identify the training needs. In this step various methods are used to identify where improvements can be made in hazard control\textsuperscript{18}. Typical methods include tasks analyses, a review of health and safety records and the determination of workers perceptions to risk.

The output of this step should give the designer of the training an understanding of exactly what hazards need to be addressed by a training course. It allows the course designer to focus in on and truly identify the hazards that may have triggered the process of training course development in the beginning. If this step is not included as a part of the course development the course designer may not understand the true nature of the hazard that they wish to train employees to avoid (or modify in the case of hazards that cannot be entirely
neutralized). If hazards are not properly identified it could cause the course designer to develop a course that does not address the true hazards that the employees are facing.

1.4.3 Identifying the Goals and Objectives

Now that the hazard or hazards are fully understood the goals and objectives of the training course can be identified. A training course should have specific goals and objectives associated with it\(^{19}\). For example specific goals might include; "the employee will know how to adjust chair height correctly and will be able to position a microscope at the correct height for their eyes," as opposed to a general goal, such as "the employee will be able to set up their workstation."

Goals become the tasks or behaviors that an employee will be able to perform upon completion of the training. These tasks or behaviors may also provide a way for a course designer to measure the impact of the training course.

For example, it may be specified that the task or behavior be performed to a certain level of proficiency upon completion of the course. If clear goals are not determined the course may not impart the information or skills that were intended, which will impact the ability of the training course to affect the hazard or hazards that are trying to be reduced.

1.4.4 Developing Learner Activities

Once the goals of a training course are determined the course designer must then decide how the instructor may best impart knowledge to the learner. The
manner that information is given to a learner has a large impact on how well the information will be used and retained by that learner, although which methods best benefit retention under a given circumstance is not always clear\textsuperscript{20}. When specifying activities or media to be used during instruction, there are many options available for a course designer. These may include video, lectures, slides hands-on activities, computer work and many others.

The decision to use one learning technique over another is a decision that should be based on many factors, such as training needs and the mental and physical make up of the trainee group. If the wrong teaching technique is chosen the course designer risks having the audience be unable to retain the information, or the audience may not be able understand the concepts or have the ability to apply the gained knowledge.

1.4.5 Conducting the Training

When designing a training course one will eventually want to conduct the training, but this is not the purpose of this stage. This initial training course is used to invite the worker to have input into and evaluate the training process that has been developed by the course designer\textsuperscript{21}. Having the employees input in the design and delivery of training may result in increased motivation of the worker to have the course succeed and may also identify weaknesses in the training course as it has been initially designed. Without this test run stage employee buy-in to the course may be weak and the weaknesses in the course may not be addressed resulting in an ineffective program.
1.4.6 Evaluating Program Effectiveness and Improving the Program

While these stages may sound very similar to the previous stage where the workers assess the course; it is quite different. Evaluating effectiveness refers to the techniques used by the organization to measure the effectiveness of the course and may be considered a more holistic approach than the previous stage where the employees were asked whether they found the course useful and where the course could be improved.

Methods to assess the effectiveness of the course include:

- Reaction by the employees
- Tests of learning
- Behavior Changes
- and Measurement of Tangible Results\textsuperscript{22}.

By evaluating the course effectiveness of a course an organization is able to determine whether that training course has met the needs of the learners and whether the course can be modified to more fully address the hazard or hazards outlined in earlier stages of the training course development. Without these stages an organization may continue to use a course that is not effectively addressing and reducing the hazard that has been identified in earlier stages of the process.
As discussed earlier improving the program has been linked with evaluating the program effectiveness into a single chapter due to their close relation. It is important to note that these two theoretical steps or action items are separate components when designing a training course. They have only been joined into a single chapter to make it easier for the reader to understand how evaluations of the training course can result in improvements to the course. They are also linked into a single chapter, as an organization that evaluates the effectiveness of the course should be doing so with the intent of improving the course if deficiencies are found. An organization should not bother spending the resources to evaluate a course unless they intend to use that information to make positive changes to the course\textsuperscript{23}.

After evaluating the course improving the program may require repeating some or all of the stages that have been previously listed as a part of the course development. This cycle of regularly assessing a training course and making changes in areas of deficiencies ensures that the training remains effective whenever the course is being used\textsuperscript{24}.

1.5 Chapter Summary

As discussed earlier in this chapter a review and conclusions section will now be given. In each chapter summary the review will be given first, followed by any conclusions that arose as a result of work performed in that part of the training course design.
1.5.1 Review

In this chapter a brief introduction to ergonomics and the issues surrounding microscope use were discussed. Background information on the client CLS was also given. Finally, the elements used to develop an ergonomic training program were discussed. These elements of the training program will now become the next chapters in this Masters Degree Project. In each of these chapters the results of the literature review, questionnaires, interviews and task analysis will be used to rationalize the decisions that were made during the development of the training course. Following the "conclusions" section the next chapter will discuss whether training was the best solution to the ergonomic hazards that were facing CLS when it decided to develop a training course.

1.5.2 Conclusions

As discussed earlier in this chapter each chapter summary will have a section titled "Conclusions". The purpose of this section is to outline issues that arose during the development of the training course when attempting to apply theory to a real world situation.

At this point in the development of the training course it would seem that no theory has yet been applied to a real world situation. This assumption is incorrect; several key decisions have already been made. First, the concept of musculoskeletal injury has been identified as being very important within the parameters of this project. Second, the framework for the development of the course was selected, which happens to be essentially the same as the OSHA
training program development stages. Third, the purpose and scope of the training has been stated without even beginning the process of training course development. These are key decisions when developing a training course.

These decisions have been made prior to any other decision about course design takes place. It seems that these decisions affect the design of the training course, which may have a significant impact on the final product. A conclusion that can be made from this information is that a training course designer needs to have a firm understanding of training course design prior to undertaking this type of project, as decisions made early in the process may have significant impacts later in the development process.
Chapter Two - Determining if Training is Necessary

In this chapter there will be a discussion of why performing advance planning is important when deciding on a control to address a hazard. This will be followed by a description of what actually occurred during this phase of the training course development at CLS, and how the decisions made during this stage of development affected the development of the training course. At the end of the chapter there will be a brief summary of the important points to consider during this stage in the development of a training course.

2.1 Literature Review

As discussed in the first chapter, the first critical element when developing a training course is determining whether training will be the most effective method of addressing hazards in the work place. Generally there is a problem that has been at least partially identified that triggers an organization to determine whether training is needed\(^{25}\). Some possible examples of triggers may include an increase in injury statistics within an organization or a request by management to develop training to in order to improve organizational effectiveness, such as improving problem solving skills\(^{26}\).

Once the trigger or triggers cause the organization to consider using a training course a fundamental question needs to be asked. Will the needs for hazard control be managed more effectively through training or should engineering or
administrative controls be considered when attempting to eliminate the occupational hazard? At this point it becomes important to be able to distinguish between the different types of controls that are available to an organization and the benefits and costs of each control, which will be discussed shortly.

When applying the different types of controls available in ergonomics technical expertise is often the only knowledge required to ensure that a particular control is working correctly within the immediate environment\textsuperscript{27}. However, how that intervention impacts the whole system requires more than technical expertise or analytic thinking, it requires an understanding of how the individual parts of the system interrelate and affect one another. This level of analysis is referred to as synthetic thinking where the behavior of the system as a whole needs to be understood or problems may be misdiagnosed\textsuperscript{28}. This is due to several shortcomings if ergonomics is applied using methods based solely on basic ergonomic science without regard for the system as a whole\textsuperscript{29}. These shortcomings of basic ergonomic science will now be listed.

1. Laboratory findings are not always applicable to real-world situations.
2. Apparently relevant findings may lack generality.
3. There is no theory to integrate all the findings of basic science.
4. The unit of analysis in basic science may not be applicable to real-world ergonomic issues.
5. The basic sciences do not provide a paradigm for describing human-machine systems\textsuperscript{30}. If only basic ergonomic science is applied the needs of the system as a whole will not be considered. The result of only using basic ergonomic science could be an intervention that is ineffective or has unintended consequences\textsuperscript{31}. Therefore implementing ergonomics within a systems perspective is vital.

When working at the systems level there are several frameworks that can be used. These may include a macroergonomic framework, a participatory ergonomic framework and a hygiene framework.

Macroergonomics looks to incorporate human-machine matches into the larger organizational context of an environment\textsuperscript{32}. When using a macroergonomic approach, organizational culture, management systems and communication patterns are all elements that need to be considered in addition to the technical aspects of an ergonomic intervention. A macroergonomic intervention is designed to jointly optimize technical and organizational needs\textsuperscript{33}.

One of the advantages of this type of approach to ergonomics is that the needs of the organization as a whole are considered when implementing ergonomic controls and the impacts of those controls on the organization are also considered\textsuperscript{34}. By using this type of approach there is often a better integration of an ergonomic control into an organization. A disadvantage of this type of
approach is that to effectively implement controls a consistent organizational change is required, which can be a very difficult process to undertake\(^{35}\). The reason this type of framework was not selected for use at CLS is that it is thought the culture at CLS is not one that is mature or experienced enough in the field of ergonomics to effectively undertake a project using this framework. The lack of experience refers to an organization that is still developing management systems, has a communication structure that is constantly changing and has not had widespread exposure to ergonomics.

Participatory ergonomics is a subset of, or perspective on, macroergonomics\(^{36}\). As a result the advantages and disadvantages of this type of approach are the same as those of macroergonomics. However, proponents of the participatory ergonomic approach argue there are specific advantages of employing participation.

1. It legitimizes the ideas that workers have accrued as a result of performing their work.
2. Ownership of ideas enhances the likelihood of implementing ergonomics successfully.
3. When people are involved in a process of change they will be better equipped to use that process in the future to solve problems\(^{37}\).

Participatory ergonomics was not used as a framework due to the inability of the client to provide enough access to staff to participate throughout the development of the training course. This issue with access was the result of the
organization having limited resources, making it difficult to have staff continuously participate. This concept of participation will be an important concept that is raised in chapter four when participation of the staff is not actively used.

This MDP has been developed in a hygiene framework, as is shown when listing engineering, administrative and training as the possible controls that can be used. The term hygiene comes from medicine where unhygienic conditions are often considered to cause ill health.  

It is argued that the primary advantage of a hygiene framework is that improvements in labor effectiveness and employee motivation can be achieved by changes to work organization through the better design of the jobs that people do. Improvements to the job are performed using engineering, training or administrative controls. The primary disadvantage of using this type of framework is that it places emphasis on the individual and their achievements even though these people are part of a larger community. Initially this was not considered a significant disadvantage, as the objective of the project was to impact the individual microscope users by making them more comfortable in their work environment.

There are two additional reasons the hygiene framework was selected. First, it is a framework that the MDP candidate am most familiar with, and feel
comfortable using. This provides the client the best product by using a framework that is well understood. Second, the client at CLS is the Environmental Health and Safety department, which is comprised of occupational hygienists and people trained in this area. Therefore using this framework allowed the researcher to have a common understanding or language to use when developing the training course with management and staff working at CLS. For these two reasons a hygiene framework is used.

The hygiene framework is by no means the only framework that can be used for the development of training such as participatory ergonomics and macroergonomics. At CLS these types of frameworks were not applicable due to the type of organization that was being worked with and the level of staff participation available. Other training course designers may wish to explore these types frameworks in the future. Regardless of the type of framework chosen it is essential that the course designer consider the whole system when performing their work as it has been demonstrated that bottom-up technical interventions may not impact the system as was intended\(^4\)

2.1.1 Types of Controls

When an organization is considering implementing an ergonomic intervention there are three categories of interventions available to them: engineering controls, administrative controls or training\(^4\). These are three categories used to group the types of interventions although often an intervention may use elements
of all three categories. There are advantages and disadvantages to using each type of control, which will now be outlined.

2.1.1.1 Engineering Controls

Engineering controls are a design change in a piece of equipment, workstation or work area that is generally a permanent one-time change. Most engineering controls require expenditure of funds, staff participation and often outside expertise if they are to be successful. This type of control is often preferred to other types of controls because if it is performed correctly the problem is generally eliminated or greatly reduced, without the need to monitor the control on an ongoing basis. Typically this type of control is more costly in the short term than other types of controls and may require an interruption in work as the control is put into place.

2.1.1.2 Administrative Controls

Generally administrative controls are considered when a suitable engineering control cannot be found. Administrative controls are usually not considered permanent solutions to a hazard as they must be monitored regularly and re-instituted on a periodic basis to retain their effectiveness. Examples of administrative controls include; job rotation, break scheduling and selection of employees for specific tasks. Administrative controls are usually less costly up front than engineering controls and are quicker to implement, although over time the control may become more expensive as it is re-instituted regularly.
2.1.1.3 Training

Training is often considered one of the possible administrative controls\textsuperscript{46} that can be used, as it is not a permanent solution to a hazard and must be monitored and re-instituted regularly to retain effectiveness. The advantages and disadvantages of training are the same as were referred to in the administrative controls section. For the purposes of this paper training will be considered its own control as it was originally proposed to CLS that the course would contain information relevant to making very simple engineering changes to the workstations and would also impart information on possible administrative controls that could be used in the workplace.

Training programs can have many purposes. Some programs are used to upgrade employee skills and meet staff requirements or provide job security for organizations in a technological or economic transition. Other purposes include basic skill development and personal development\textsuperscript{47}. In training programs, objectives typically fall into one of three broad categories\textsuperscript{48}.

- **Information** – This imparts knowledge of risks, hazards and their implications for human health and safety.

- **Attitude/Behavior Alteration** – The ultimate objective of this category is to change the attitudes and thus behaviors of the learner. This can be a most difficult goal to achieve.
• **Skill Achievement** – Similar to attitudinal alteration, this goal relates to skills that are necessary for the learner to complete the job for which they are training.

### 2.1.2 Choice of Controls

At this stage in the process it is not yet determined whether a training course will be chosen to control a hazard that has been identified in the work place. The organization must now determine how to best spend its money to deal with the problem or hazard.

When considering a solution organizations should evaluate:

- Cost to implement a control
- Time to implement the control
- Ease of use of the control
- Effectiveness of the control

In essence the organization needs to use some strategy to compare the types of controls available to them. A cost benefit analysis is one valuable method of comparing the controls.

A cost benefit analysis provides a framework for organizing information, where the advantages and disadvantages of a control can be listed, the relevant economic values are determined and the options can be ranked on economic
worth. While it is not the purpose of this document to describe the intricate details of performing this type of analysis the basic steps will be listed.

- Identify the problem and define the possible solutions,
- Identify the benefits and costs of each solution,
- Value the benefits and costs of each solution,
- Tabulate the annual benefits and costs of each solution,
- Calculate the net benefits for each alternative,
- Compare the solutions by their net benefit,
- Test for the effects of changes in assumptions,
- Make the final recommendation.

It should be noted that a strictly financial cost benefit analysis does not include the social benefits that may be experienced by individuals, the organization or society as a whole. There are techniques used in this type of analysis that can factor in these variables.

If an organization does not use a strategy to determine the most suitable control they are at risk of addressing the hazard in an ineffective manner that may use resources inefficiently. If a cost benefit analysis is used it should be noted that even after performing this analysis an organization may not choose the most cost effective solution, perhaps due to excessive up front costs or other factors, but the organization will realize the merits and detriments of each type of control and be able to make an informed decision. The important point is that an organized
strategy should be used when deciding on what control or controls should be used.

2.2 Calgary Laboratory Services

In this portion of the chapter the theoretical steps discussed in section 2.1 will be compared to the decisions made during the development of the training course at CLS. Differences between the theoretical information and practical decisions will be explained and whether it was thought these discrepancies impacted the development of the training course.

2.2.1 Trigger

As discussed in the first portion of this chapter there is usually a trigger that alerts the organization that there may be a hazard or hazards that require attention. The trigger in the development of the CLS training course resulted from work performed earlier by students in the Faculty of Environmental Design. These students were apart of a 702 class that worked for clients outside the university in order to develop real world consulting experience.

The project was titled "The Ergonomic Analysis and Design of an Adjustable Microscope Stand", and was completed in December of 1998. During the course of this project the students used documentation reviews, a task analysis, a design analysis, surveys, interviews and client feedback to explore the ergonomic problems associated with microscope use. The team identified several problems with the current workstations and work organization at CLS.
These problems included; limited adjustability, limited task variation, static work postures, awkward work postures and continuous muscle demands\textsuperscript{54}. The team proposed an engineering solution and developed a model of a working adjustable microscope stand that can be taken further into development if CLS determined that this solution would meet their needs.

The development of the microscope stand has not been further developed as of the publication date of this document. However the 702-group project documented evidence of the ergonomic hazards involved with the microscope work at CLS. In addition there are undocumented concerns of the Environmental Health and Safety staff working at CLS. The information from the 702 project and the concerns of the Environmental Health and Safety department are the triggers raining awareness that there are hazards that need to be addressed.

2.2.2 Decision over Type of Control

At this point in the development of the training course there is a significant departure from the recommended use of a strategy or cost benefit analysis. CLS selected the training control to address ergonomic hazards present in the work place and they precluded a formal cost benefit analysis of other controls.

CLS opportunistically accepted a proposal specific to the development of a training course meant to address ergonomic hazards. I the researcher put forth the ergonomic training proposal, as it was the specific topic I wished to pursue for my MDP work. The decision to develop a proposal specific to training course
development and the acceptance of that proposal means that engineering and administrative controls were not fully assessed when determining the type of control to be used.

When applying the first theoretical step that is being used as an action item in this MDP there is a direct conflict with the literature as training was the chosen intervention without the assessment of the other intervention strategies. This conflict arises, as training was the proposed to both the faculty and CLS as the topic of the MDP. While the MDP supervisors would have most likely approved changing the type of intervention based on research, the client was not interested in supporting the research project that would result in other types of controls. This may have been a result of past research that was performed on possible engineering controls that proved too costly to take forward or a simple unwillingness to address other types of controls.

As a result, the training course that was initially proposed needed to be the intervention that was used. However, just because this MDP was specifically addressing training controls it should not send the message that an organization should preclude a formal consideration and assessment of the other types of controls available to them. In fact the preclusion of administrative and engineering controls may have an impact on the ability of the training course to instigate positive change at CLS.
For example a training course may give participants the knowledge to make changes to their workstation by modifying the height of the microscope. However without the engineering controls (i.e. adjustable microscope) to make those changes the impact of the knowledge presented in the course may be limited. Another example might be that simple administrative controls are given as part of the training course. If the participants in the course are not allowed by management to instigate these administrative changes, such as microbreaks, the effectiveness if the course will again be limited.

Individual controls can have positive impacts on the work environment\(^5\). It is likely however when administrative, engineering and training controls are used in conjunction with one another that a greater benefit would be realized\(^6\). When CLS uses the training control they should see some positive results however CLS will only achieve the greatest results when other controls are used in conjunction with training. This is because CLS will have not addressed the problem from a systems level unless all three types of controls are put into effect.

Examples of other controls that may complement the training control at CLS include the purchasing of adjustable workstations to allow the training course participants to apply workstation design principles given in the training course. Another example would be to have management support the process of implementing administrative controls that those participants in the training course learned the value of and are try to apply. Training on its own may result in
positive outcomes although the use of other complementary controls should increase these positive outcomes. It should also be considered that the provision of training without the support of other controls by CLS, may result in staff members that are frustrated by the process of trying to apply learned information in an environment where management is not supporting the entire process. This is an issue that CLS will need to address as the training is used across the entire organization.

While the decision over the type of control did not follow the literature there was valuable work that was performed at this stage of the project. A discussion of the reasons for the difference between what the literature states and the decision made in the development of the training course will take place at the end of this chapter.

2.2.2.1 Gaining Support

Successful training programs rely on identifying and involving key people involved in the project during each stage of the project. During this portion of the design of the training course players in a position to provide assistance in the initial stages are identified and involved in the process. At CLS there are many players that need to be involved during this stage, which include:

- Health and Safety Personnel
- Senior Management
- Human Resources Managers
- Area Supervisors.

Without the involvement of all these players there may not be the support necessary to complete this project, as each person can assist in the development of the project in their own way.

The health and safety personnel were able to coordinate the project within the organization, which included organizing meetings, on-site visits, questionnaire distribution, raising awareness of the project and providing essential information on the work environment within CLS. Senior management provided funding for the project and ensured that the organization would cooperate with the objectives of the project. Human resources managers normally coordinate much of the training at CLS and along with health and safety personnel ensured that the course could be incorporated into the current training structure at CLS. Finally, area supervisors agreed to provide access to their work areas and provide staff members that were interested in assisting in the development of the training course.

It should be noted that it is essential that staff be involved in the development of the training course whenever it is feasible. While management can provide access and support the staff will in the end determine whether the training course is a success.
2.3 Chapter Summary

The following sections will review the information presented in this chapter and will address areas where the recommendations from the literature were not met.

2.3.1 Review

In this chapter the advance planning work performed prior to the development of a training course was discussed. Literature was reviewed that pertaining to triggers that initiate the decision to implement a control within an organization. The advantages and disadvantages of engineering, administrative and training controls were outlined. At the end of the literature review it was stressed that a strategy is needed to decide between different controls and a cost benefit analysis was tabled as being one valuable tool that could be used to assist an organization making this decision.

In the second portion of the chapter the differences between the proposed theoretical steps in the development of the training course and the actual steps that were taken were compared. The previous project that became the trigger mechanism for CLS was discussed. It was shown that there was no formal strategy used to decide between the types of controls. This was due to the order the MDP process was undertaken with the proposal of training followed by the research, which states that other avenues of interventions should also be considered.
Regardless that a formal decision making strategy was not employed, it was shown that during all stages of the development of a training course it is important to gain support from the key players, something that is not stressed in literature specific to ergonomic training course design but is prevalent in other corporate training literature and ergonomic program development literature\textsuperscript{59}.

2.3.2 Conclusions

There was a departure from the recommendations of the literature in the development of the training course, as there was no formal decision making process employed by myself when choosing training as the intervention to be used. This logically leads to the question as to whether the ergonomic hazards associated with microscope use at CLS could have been better addressed through the use of engineering controls or administrative controls instead of training?

Clearly the development of this training course was opportunistic, although each party gained specific deliverables. I the course designer received an MDP project to use in the completion of degree work and CLS received a possible solution to their workplace hazards. This opportunistic proposal for training course design was undertaken because CLS assessed they were receiving value for their support, also CLS wished to use the training control to raise awareness of ergonomics within the organization.
It could be argued that after completing the initial microscope stand project and having a graduate student develop the training course, as opposed to a paid consultant, CLS felt comfortable with the cost and benefits of this control without the need to resort to a formal decision making strategy. Alternatively CLS may have simply been unwilling to develop other types of controls. This may have been partially due to the realization that past attempts at engineering controls had proved to costly upon completion of those projects such as the 702-microscope project.

The process of gaining support for the training course project meant that key personal had to be convinced to provide assistance, one of which was upper management that controlled budget allocations. These managers would not have released funds without a decision that this expenditure would provide suitable benefits for the company at the proposed cost. So while a formal decision making strategy was not used when determining an intervention for CLS; the process of submitting the proposal and gaining support instigated it's own decision making process that resulted in the decision to use training.

In this MDP the decision to use training as a control was opportunistic. However, just because this MDP was specifically addressing training controls it should not send the message that an organization should preclude a formal consideration and assessment of the other types of controls available to them. The risks being
that an organization will not use resources in the most effective manner possible and will not reap the greatest benefit by not using complementary controls.

When working from a hygiene framework the three controls must be assessed and used in conjunction when appropriate or an organization is not assessing a problem at a systems level. Without the assessment of other control types it is possible that the selected control, in this case training, may not be effective at addressing the hazards in the work environment. In the case of training, if there is not support for other control types, staff may become frustrated as they attempt to apply the principles learned in the training course. It is demonstrated in the literature that an individual control will become more effective when other types of controls are used together to address a problem or hazard.
Chapter Three - Needs Assessment

In the last chapter the focus was on the selection of a control to address a hazard in the workplace. As training was selected as the control, the paper will now shift focus onto the processes used to develop, perform and keep a training course effective. In this chapter the recommended steps used to identify the training needs will be described. This will be followed by a description of how these steps were used at CLS. In the summary the important points to consider from this chapter will be reiterated.

3.1 Literature Review

An analysis or needs assessment forms the foundation for the entire development of the training course\textsuperscript{60}. It is written that a needs assessment for training course design must include three basic components\textsuperscript{61}.

- A hazard assessment,
- A profile of the target population,
- The social context of the training.

Other literature stresses the importance of the cooperation of both the employer and employee in the initial stages of the training course development\textsuperscript{62}.

In the following sections the purpose of hazard assessments, target population profiles and the social contexts of training will be discussed. The cooperation of
the employee and employer will be discussed as a subset of the social context of
the training.

Before discussing the steps in the needs assessment it should be noted that
there are many different techniques that can be used to perform needs
assessments. Some of these techniques include:

- Surveys,
- Interviews,
- Literature reviews,
- A tasks analysis,
- Document reviews\textsuperscript{63}.

This paper will not outline the correct method of performing each of these
techniques; only make the reader aware of the many different methods that can
be employed when performing a needs assessment.

There is no one technique that is the best method to use when performing the
needs assessment. Literature suggests a combination of the techniques be used
in an ongoing process to gather information pertinent to the development of the
training course\textsuperscript{64}.

3.1.1 Hazard Assessment

The purpose of a hazard assessment is to identify high priority problems that
need to be addressed by the training course\textsuperscript{65}. For example, are there specific
pieces of equipment that are causing injuries, are there certain tasks that the staff feel uncomfortable performing, do safety records show injuries within a specific work area of the organization or does literature demonstrate that certain jobs pose a higher risk of injury to the employees. If a formal hazard assessment is not performed the hazards may not be properly addressed by the training course. Furthermore if these hazards are not addressed by the training course the maximum benefits of training course use will not be realized.

3.1.2 Population Profile

A population profile attempts to answer a broad set of questions concerning the work force. Some of these questions may include; who can benefit most from the training, what prior knowledge or training do the staff bring to the process, what is the literacy level of the staff or what type of training sessions do the staff benefit most from. By understanding the group of people that are a target for the training, the course designer is better able to tailor the goals objectives and training techniques for those who will be involved in the course.

The importance of understanding a population becomes important when reading that there is a consensus among adult education practitioners that if a training course is to be effective it must address an area of knowledge or skill that the learner does not possess and would find valuable. Terdy writes,

"The learning experience should develop from the level of participants' understanding, background and experience, and it should be based on the
needs and interests that they themselves feel or that they can be assisted to recognize"\textsuperscript{68}.

Therefore, if a training course designer does not understand the target population, it would be impossible to design an effective training course for learners as defined by Terdy and other adult education practitioners.

3.1.3 Social Context

Coming to an understanding of the social context of an organization can be a very difficult task. When attempting to understand the social context of an organization the training course designer is attempting to identify the forces that may support improved health and safety conditions and those that may pose barriers to improving the conditions\textsuperscript{69}. For example, an organization with strong union protection may afford workers the opportunity to speak freely about potential hazards in the work place. Conversely, barriers to improved health and safety conditions may include items such as production pressures or poor job security. By understanding these forces, a training course designer is able to identify and make an effort to use the forces that will support the training course and attempt to address the forces that are a barrier to the course being effective.

3.1.3.1 Manager – Employee Cooperation

As mentioned previously, understanding the social context within an organization can be difficult. By ensuring that managers and employees work together in the initial stages of training course development, barriers to the course development
may be overcome and the positive forces may be used to their greatest potential.

It is recommended that three broad guidelines be followed to ensure that the both the employer and employee are satisfied with the training process.

1. The training must be based on agreed upon objectives by the two parties (employer and employee).
2. The parties must work together in determining the contents of the training, materials and the plan for carrying out the training.
3. The parties should both supervise the training program and participate in adapting it to their changing needs.

By using these three guidelines, and having the employer and employee working as a team to develop the general objectives, needs assessments and reviews of the training program, the program is more likely to meet the goals and objectives as understood by both parties. It is important that this cooperation begins early in the development of the course and continues throughout the lifespan of the training course.

3.2 Calgary Laboratory Services

There were a number of different information gathering techniques used during the development of the training course at CLS. These included; a survey, a task analysis, interviews with managers and staff, and a literature review. This portion
of the chapter will be broken into three sections; hazard assessment, population profile and social context. Pertinent material from each of the different information gathering techniques will be used in each section in order to provide an accurate overview of the needs required for the CLS training course.

### 3.2.1 Hazard Assessment at CLS

A task analysis, literature review and survey were the primary means used to gather information about the hazards of microscope use in the laboratory environment at CLS. Each of these information-gathering techniques will be given its own section.

#### 3.2.1.1 Task Analysis

A task analysis is a useful tool for gathering data about a specific work environment and specific work tasks. All task analysis information for this project was performed during the initial microscope design project as part of a University of Calgary 702 class project in which I performed a portion of the work. The 702-document will be referenced throughout this task analysis section (3.2.1.1). Any task analysis information gathered during this training course project will be identified as separate from information gathered during the 702 project.

Task analyses were performed at 2 sites, the Central Lab and the Foothills Hospital. Analyses were performed in the Cytology, Hematology, Chemistry and Microbiology areas. By performing the task analyses at 2 different sites, and in 4
different areas, information was gathered from a representative range of workstations used by employees of CLS. The task analysis was performed using video, photography and direct observation. Only those employees that consented to be documented in the task analysis were recorded. Appendix 1 contains a sample copy of the consent form[^73].

The task analysis gathered information regarding basic workstation arrangement. This included measurements of height, depth and width of both tables and chairs. Appendix 2 shows the checklist that was used during the observations[^74]. Informal feedback was also provided by the users on task cycles, shift lengths, breaks and symptoms experienced while performing microscope work. After the observations and records were reviewed, the task analyses yielded valuable information regarding work postures, the work environment, the nature of microscope work, and current approaches to microscope adjustment at CLS. See Figures 3.1 and 3.2 (below) for samples of workstations used at CLS.

![Figure 3.1 - Multi-user microscope workstation at CLS](image-url)
The task analysis observations are divided into two lists. The first bullet point list is composed of observations made during the analysis that are considered risk factors for musculoskeletal injury. The second list is composed of risk factors that were identified through informal discussions with staff or supervisors.

During the analysis observed risk factors for musculoskeletal injuries included:

- Limited space, the work environment had a number of staff working at cobbled together workstations.
- Microscope users attempted to adjust microscope heights and tilts, although this was often done inappropriately (i.e. height adjustments were often not high enough).
- Inappropriate and improvised arm/wrist rests. This may lead to pressure points on the soft tissue of the users' forearms.
• Inappropriate use of the microscope workstation. This included improperly adjusted chairs and infrequent use of footrests.

• Excessive flexion of the wrist while operating microscope controls due to lack of adjustability of the workstation and the habits of the user.

• Users assuming awkward postures to use the microscope and secondary devices, such as computers and writing tools.

• Workstations not easily adjustable.

• Users observed with poor seated posture due to habit, lack of adjustability and lack of knowledge how to adjust.

• Users assuming awkward neck and shoulder positions due to height or angle of microscope.

• Static postures held for long periods of time due to job design and poor work habits.

Risk factors for musculoskeletal injuries identified through informal staff conversations:

• The static nature of the work posture creates stress on the user.

• Little or no task variation adds to the stress created by the static postures.

• Employees are unsure of proper workstation set-up.

The risk factors for musculoskeletal injuries in the CLS environment can be categorised into four groups. The first group is made up of problems inherent in integrating microscope use with a standard writing/computer workstation. For
most workers to place a microscope at the correct viewing height means the microscope must be lifted a significant amount. While this adjustment may place the oculars at the correct height, the microscope controls are now too high to be used comfortably. The following two figures provide examples of workstations (figures 3.3 and 3.4 below) modified by their respective user.

![Figure 3.3](image1)

**Figure 3.3** -
Commercially available pivoting armrests incorporated into a workstation

![Figure 3.4](image2)

**Figure 3.4** -
User designed armrests used to customise a workstation

The second category of musculoskeletal risks can be considered risks due to a lack of education\(^7^8\). The employees at CLS are provided with adjustable chairs and assorted blocks to adjust their workstations. However, these pieces of
equipment are often improperly used, suggesting that the staff may not understand how to adequately adjust their workstations.

The third group is a lack of ergonomic workstation aids\textsuperscript{79}. Some users have access to footrests, quality adjustable chairs, and other aids. However, some users did not have wrist rests for keyboards or arm rests, and some employees were using older chairs without the necessary support for daylong use.

The last group is risk factors relating to static postures\textsuperscript{80}. The nature of the work requires users to maintain static postures for extended periods of time, while performing highly repetitive tasks. The nature of this type of microscope work can have the users performing hundreds of tests in a single day or alternatively can have a microscope user working with a single slide for a long period of time.

3.2.1.2 Literature Review

For this project the literature review was a document search performed on refereed journals, books and web sites with information relating to computer or microscope workstations. The review was performed to develop a broad understanding of workstations and gather information specific to the hazards of using microscope workstations. Sources of information used in the 702-class project are reused in this literature review and additional sources of information were added to supplement information generated from the past project. When 702-class project information is used the original reference document is used as
The material has been rewritten, changed or added too in order to include the additional sources of information that were gathered.

The University of Calgary library, Internet, and interlibrary loans were all sources that were used when gathering information. Journals such as Applied Ergonomics, Ergonomics and Proceedings of both the Human Factors Association of Canada and the Human Factors and Ergonomics Society were used in gathering information specific to microscope workstations. Information was also gathered from the Internet but was restricted to information collected from university run ergonomic web pages, ergonomic laboratory web pages and government web sites.

A review of the literature revealed that a seated workstation is the most appropriate for microscope work due to the precision of the task, degree of body stability required and the length of the work period\(^8\). With this in mind there are several critical dimensional factors in seated workstation design\(^9\).

- Correct eye position relative to viewing tasks
- Seat height, depth, back angle and footrest position
- Clearance for the legs and knees
- Height and depth of work surfaces
- Hand and foot reach requirements

The following figure suggests several ranges of adjustment for seated workstations to ensure that the critical dimensional factors are met\(^{83}\). The
obvious exception to this will be the placement of the microscope, which cannot
be properly adjusted by such a workstation and remain suitable for tasks such as
writing and data entry.

![Diagram of seated workstation with measurements]

Figure 3.5 - Ranges of adjustment required for seated workstations.

The American Society of Cytopathology web page reports that 70.5% of
Washington cytotechnologists report some form of shoulder, neck or upper back
problems. Ninety one percent of those reporting symptoms have at least one
symptom, and 30.8% have at least four symptoms. Another study reports that
84% of microscopists in Stockholm's county hospital laboratories suffer from job
related musculoskeletal pain. Many other studies report similar findings on the
occupational hazards associated with microscopy work. It is evident that
microscopists experience alarmingly high rates of musculoskeletal discomfort
and injury.
Recommendations have been made that employers can address to improve microscope work. These include:

- Replacement of microscopes with visual projection systems – Projection systems allow workstations to be set up in a manner that is less physically stressful to the operator. The drawback with such projection systems is the cost and the inability of most systems to display an image in as fine a detail, as the human eye is able to detect.

- Training programs for operators – Operators should receive instruction on the correct use of their microscopes and workstations. These instructions should include information pertaining to the adjustment of chairs, armrests, accessories and workspace organization.

- Job rotations and rest breaks – With the frequency of musculoskeletal injury and discomfort in microscope work, jobs should be designed so those operators can perform different tasks unrelated to microscope work. Operators should also be encouraged to take frequent, micro-rest breaks to give relief from static postures.

- Ergonomic workstation design – Design principles involved in the ergonomic design of workstations are of the utmost importance when designing a microscope workstation. Workstations must encourage the maintenance of good posture and reduce the necessity of repetitive motions. Suitable adjustment should be provided so the operator can adapt the workstation to their body dimensions.
- Ergonomic design of microscopes – Ergonomic microscopes should be adaptable to users that are working in a properly designed and adjusted workstation. The eyepieces should be placed in a position that does not compromise the user's posture. Microscope controls should be designed so that the user is able to control the scope from a neutral position, not having to reach, flex or bend awkwardly.

3.2.2 Population Profile

The primary tools used to profile the population during the development of the training course were the survey and interviews with management and employees. These results will each be given a section. All information used in the population profile was developed specifically for the training course project. No information from the 702-class project was reused.

3.2.2.1 Survey

The purpose of the questionnaire survey was to gather information from microscope users at CLS, primarily regarding demographics, symptom prevalence and the nature of musculoskeletal discomfort.

The survey was distributed to 182 microscope users at CLS. A copy of the questionnaire was given to Ms. Carol Becker, the Environmental Health and Safety Coordinator at CLS. Ms. Becker provided a cover sheet explaining the nature of the questionnaire and the methods used to ensure confidentiality. The researcher to ensure that recipients did not feel coerced into participating in the
questionnaire reviewed this cover letter. In addition consent forms were attached as part of the questionnaire in accordance with University ethical guidelines, a sample the consent statement and questionnaire may be viewed in Appendix 3. The consent form also stressed that recipients could choose to not participate in the process at any time, further underlying the fact that the employees were free to participate in any manner they saw fit including abstinence. Questionnaires were returned via ballot boxes so that participants were able to participate without knowledge of management.

Of a total of 182 possible returns, 123 completed questionnaires were returned, resulting in a high 67.6% return rate. The user population is approximately 86% female, with 90% of the users being right handed. Of the staff that returned questionnaires 80% have worked using a microscope for in excess of 6 years. Of the respondents 63.5% share a workstation with other users. Out of the 63.5% that share stations, 38.5% change stations hourly, 53.8% change stations daily and 7.6% change stations weekly. Of the 123 respondents 104 reported experiencing pain or discomfort; a rate of 84.5%. The following table illustrates the frequency of pain by body part. In Table 3.1 "never" was defined as absolutely no incidents of discomfort, "sometimes" was defined as isolated incidents of discomfort and "frequently" was defined as daily incidents of discomfort.
Table 3.1: Frequency of discomfort by body part among the 104 respondents reporting pain or discomfort.

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Never</th>
<th>Sometimes</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>30</td>
<td>52</td>
<td>22</td>
</tr>
<tr>
<td>Neck</td>
<td>10</td>
<td>59</td>
<td>35</td>
</tr>
<tr>
<td>Shoulder</td>
<td>20</td>
<td>50</td>
<td>34</td>
</tr>
<tr>
<td>Arm/Hand/Wrist</td>
<td>33</td>
<td>42</td>
<td>29</td>
</tr>
<tr>
<td>Back</td>
<td>39</td>
<td>47</td>
<td>18</td>
</tr>
<tr>
<td>Legs</td>
<td>69</td>
<td>28</td>
<td>7</td>
</tr>
</tbody>
</table>

Of the 104 microscopists experiencing pain or discomfort, 67.3% reported that the pain continued for more than one hour after discontinuing work at the microscope and 44% reported that the discomfort prevented them from working in an efficient manner. 33% of the respondents reported that their discomfort would awaken them in the evening and 34% reported that the discomfort interfered with daily activities such as eating, writing or sports.

Further more, the surveys reveal a high prevalence of musculoskeletal discomfort across all work areas and positions (see Table 3.2) that were surveyed at CLS. Although the majority of the respondents were technologists (86%), the data indicates respondents in other positions reported similar conditions.
Table 3.2: Percent of Respondents reporting discomfort by working group

<table>
<thead>
<tr>
<th>Working Group</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro Biology</td>
<td>82.7</td>
</tr>
<tr>
<td>Anatomical Pathology</td>
<td>86.6</td>
</tr>
<tr>
<td>Hematology</td>
<td>75</td>
</tr>
<tr>
<td>Urinalysis</td>
<td>81.8</td>
</tr>
<tr>
<td>Cytology</td>
<td>100</td>
</tr>
<tr>
<td>Other</td>
<td>83.3</td>
</tr>
</tbody>
</table>

3.2.2.2 Interviews

The purpose of the interviews is to gather more detailed information from microscope users at CLS to supplement the material received from the task analysis and survey. The information from the interviews relates to the individuals’ experience of working at microscope workstations, and addresses the perceived causes of musculoskeletal discomfort. The interviews also revealed suggestions for improving the work experience and methods to reduce the risk of discomfort or injury, which are used later in the project.

Supervisors were asked to find volunteers for the brief 30-minute interviews. In addition Carol Becker of the Environmental Health and Safety department identified several management personnel that consented to be interviewed. The interview information and consent forms can be found in Appendix 4.
In total 11 staff at CLS took part in the interview process. The results of the interviews are described in this section and relate to the perceptions of personal causal factors for musculoskeletal symptoms. A qualitative analysis was performed to show themes in the ideas and perceptions expressed. This analysis consisted of taking the interview information and attempting to find common responses to questions posed during the interview. Literature refers to this type of qualitative analysis as pattern coding\textsuperscript{89}. Using this type of analysis allows the researcher to find similarities in the data. It also allows the researcher to take the similar phrases, group them, and measure the frequency of the responses if required. When using this type of analysis there is typically a small number of resulting categories of data\textsuperscript{90}, which may make the final analysis easier to perform. Initially in the analysis there may be a large number of categories, however as further data is gathered it is often the case that there are limited similarities between the data sets\textsuperscript{91}. This allows the researcher to identify the core data categories for use in the analysis.

In this project pattern coding was only used as a tool to identify the categories of responses given by the interviewees. By generating an understanding of these categories it was possible to determine the issues the microscope users perceive as being the cause of their discomfort. The pattern-coding scheme used to analyze the interviewees' responses to both direct and indirect questions of perceived cause is divided into three categories, listed on the next page.
- Nature of the work
- Nature of the workstation
- Nature of the worker

When replying to a question the interviewee was not given additional information unless they specifically requested clarification.

The following table gives a sample of the reasons that microscope users identified as causing their musculoskeletal discomfort.

Table 3.3: Microscope users' common perceptions of their personal causal factors of musculoskeletal discomfort (examples of interviewees' comments).

<table>
<thead>
<tr>
<th>NATURE OF WORK</th>
<th>NATURE OF WORK</th>
<th>NATURE OF WORKER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasks, organization, duration etc.</td>
<td>STATION, Physical demands, relationship of the user to the environment etc.</td>
<td>Individual worker factors</td>
</tr>
<tr>
<td>&quot;at the scope all day&quot;</td>
<td>&quot;old equipment&quot;</td>
<td>&quot;need training&quot;</td>
</tr>
<tr>
<td>&quot;quotas to meet&quot;</td>
<td>&quot;arm rests at fixed heights&quot;</td>
<td>&quot;not aware of my posture&quot;</td>
</tr>
<tr>
<td>&quot;lack of variety in the work&quot;</td>
<td>&quot;ergonomic scopes needed&quot;</td>
<td>&quot;awareness of risks low&quot;</td>
</tr>
<tr>
<td>&quot;always busy&quot;</td>
<td>&quot;new equipment is badly needed&quot;</td>
<td>&quot;training on equipment use would be valuable&quot;</td>
</tr>
</tbody>
</table>
3.2.2.3 Population Summary

By using the survey and interview data we see a population of microscope users that experience high rates of musculoskeletal discomfort regardless of the work area they are part of. The microscope users' pain and discomfort is most prevalent in the head, neck, shoulder and hands/wrists. The perception of the microscope users is that the cause of their discomfort is multi-factorial. These factors include the environment, the task, and personal risk factors. The perception of the workers is consistent with the results of the task analysis, demonstrating that the risks to the workers are multi-factorial. The rates of discomfort are also very similar to other studies shown in the literature review section. It would seem to suggest that the workers at CLS are typical of organizations with large numbers of microscope users and that the microscope users are also aware of many of the risks that they are exposed too, although they may not understand how to address these risks.

3.2.3 Social Context

The social context at CLS was determined primarily through discussions and material provided by the Environmental Health and Safety contact Carol Becker and through the interview process. As with any large organization the social context can be difficult to understand therefore it becomes important to identify both the barriers and supportive forces for change. In order to clearly outline
both the barriers and supportive forces they will be outlined in bullet format. This will be followed by a brief discussion of employee management cooperation.

Barriers to Change at CLS:

- Time restrictions – Many staff identified that they were very busy and were unsure that CLS could make enough time available to staff members to complete training courses.
- Limited resources – As with many government agencies that have experienced cutbacks there is not a large array of financial resources to support an extensive training program focused solely on ergonomics.
- Misunderstanding of Ergonomics – Many staff members do not understand the ergonomic process and as a result do not necessarily feel that there is any benefit to participating in a training program focused on this topic.
- Miscommunication – Some staff feel that the organization or management does not really support the objectives of a healthy safe work force.

Support to Change at CLS:

- Staff Eagerness – Many staff are very interested in having a program developed with their input that will address some of the pain and discomfort they have been experiencing.
Commitment of Management – At both the executive and managerial level there is a commitment to employee health and wellness, which has been documented in the CLS Safety and Environmental Manual.

Effective health and Safety department – CLS has dedicated health and safety personnel that already coordinate a variety of services and training programs and are interested in the development of an ergonomics program.

The overall context under which the training course is being developed is a social environment that is eager to see change but where there has been difficulty in performing change in the past. The reasons for these difficulties have been outlined in the preceding bullets. The primary issues preventing change are the limited resources of the organization and miscommunication between management and staff. In the past staff have been disappointed when initiatives from management have not been taken to completion and management has had difficulty communication the issues surrounding the problems with these initiatives. The primary reason management has problems completing these initiatives relates to the limited financial resources available.

The limited resources of the organization have been addressed by having a student developed training course that involves little financial outlay for CLS. Miscommunication between management and staff has been addressed by constantly updating staff on the progress of course development, informing staff
of the different methods that can be used to participate in the process by use of
the company newsletter and including staff volunteers in the initial training
course to analyze the content. In addition, at each point in the development of
the course where staff members were participating there were informal
communications with staff to update them on how the process was proceeding.

It is also important to ensure that the forces supporting change are used to their
greatest potential. In this case the support of management was used to allow
virtually unlimited access to all work areas at CLS for data gathering purposes.
The eagerness of the staff to participate was used to further gather data through
interviews, surveys and observation beyond what is expected in many research
projects (see questionnaire response totals for verification). Also the staff
members were encouraged to participate in any manner they wished in order to
ensure that the risks found in the workplace would be analyzed during the data
gathering process. The eagerness of staff resulted in a great deal of data that
could be used and analyzed.

By having and understanding of the forces supporting and preventing change at
CLS it was hoped that work could be performed in such a manner that forces
hindering change could be reduced or eliminated and the forces supporting
change could be used to their greatest potential. Without the development of an
understanding of the social context these positive and negative forces may not
have been addressed. This may have resulted in a great deal of extra work developing the training course and possibly the ultimate failure of the course.

3.2.3.1 Employee – Management Cooperation

Earlier in the chapter it was demonstrated that it is very important for the management and staff to work together during the development of a training course. As mentioned in the preceding bullets there appear to be miscommunications or misunderstandings between the staff and management at CLS. During this point in the development of the training course, it is imperative that both the management and staff are involved and that the remaining staff are informed of the process.

This was accomplished in a number of ways at CLS during the initial stages of the project. Manager participation from each of the different work areas was encouraged during the initial stages of the course development. Furthermore staff participation for the interview process and survey was sought from each of the different work groups across the organization. Carol Becker of the Environmental Health and Safety department at the direction of myself also sent out information to staff informing them of the project and the methods they could use to participate. By using these different methods of participation it was hoped that awareness of the project was raised and that both the staff and management felt that their level of participation was having an effect on the outcome of the training course.
In chapter four during the selection of the goals and objectives the participation of staff was not solicited. It is important to address that this lack of participation has an impact on the context under which the course was developed. A lack of cooperation at that stage in the course development may have a number of outcomes on the final product. The exclusion of staff from participating in this section of the development could be viewed by the staff as a lack of management commitment to the project, if there is the realization that staff were meant to be included in this part of the course development process. Staff may also feel that the course has not represented their views, if the perception is that management is driving the development process.

If management and staff had worked together on this portion of the course development it is likely that the level of acceptance of the training course would have been greater. This is because the staff members are able to see how their views were represented in the final product. Without the cooperation and participation in the selection of goals there should be other methods that are employed to encourage staff to accept the training course. This issue is also raised in chapter four when the exclusion of staff from the development process is discussed.

It should also be considered that CLS only chose to address the training control within the hygiene framework. This could result in management-staff cooperation issues that arise as staff members attempt to apply principles learned in the
training course. These issues may affect the social context when the training course is used across the organization. This is because staff may become frustrated that management is not supporting or is perceived to be not supporting the process of change in the CLS work environment. The overall social context of a project is one that must be considered whenever decisions are being made during the project. This issue will be addressed throughout the document at appropriate points in the decision making process.

3.3 Chapter Summary

The following sections will review the information presented in this chapter and will provide some conclusions that result from using this information.

3.3.1 Review

In this chapter the focus of the paper shifted from the selection of a control to the importance of understanding the needs of an organization when developing a training course. The importance of performing a hazard assessment, developing a population profile and having an understanding of the social context of the organization were all outlined. This was followed by an application of these principles to the development of the training course at CLS, which is the focus of this summary.

During the hazard assessment and population profile a number of important points were made. A literature review demonstrated that those people who perform microscope work as a part of their job have a high rate of
musculoskeletal pain and discomfort. Through the task analysis it was shown that the workstations at CLS have risk factors for musculoskeletal pain and discomfort due to the design or use of the workstations and the nature of the work. The survey clearly demonstrated that the staff at CLS experience symptoms of pain and discomfort and that those symptoms appear similar to those outlined in the literature. Finally, interviews showed that the staff perceived a multidimensional cause for their pain and discomfort, which included the nature of the work, the nature of the workstation and the nature of the worker.

When attempting to understand the social context of the organization it was discovered that there were a number of positive and negative forces at work affecting the development of the training course. Perhaps the most significant was a misunderstanding or lack of communication between management and employees at CLS. This was addressed by encouraging all staff to participate in the initial stage of the training course development and keeping staff informed of what methods of participation were open to them. It was also sown how forces supporting change were identified and capitalized upon to increase the chances of the development process succeeding.

Now that a broad range of needs have been identified within the organization, the focus of the paper now turns to addressing those needs through the selection of the goals and objectives of the training course, which follows the conclusions section.
3.3.2 Conclusions

In this portion of the project I was able to closely follow the recommendations that were made in the literature review section. The literature review identified a hazard assessment, population profile and developing an understanding of the social context as being key elements of the needs assessment. Without performing all of these steps I would argue that it would be difficult, if not impossible, to develop a training course that effectively met the needs of the target population. However, there are barriers to performing the steps identified in the needs assessment.

The largest barrier to overcome is time. The tools used for the needs assessment are time intensive. The task analysis involved more than 16 man-hours of on-site time, the survey involved developing a questionnaire, distributing it to 182 users and processing 123 responses. The interviews took approximately 8 hours of on-site time; the document review was time intensive and can be expensive if documents need to be ordered. While this information is valuable, it can be expensive to gather this amount of information for a single project.

In the future it is recommended that CLS continue to use this information as a starting point when developing these types of projects, although effort should be made to keep this information current. Updating the information on a regular basis will be less expensive than performing the work a second or third time.
when new projects begin. By regularly updating the information CLS can effectively amortize the cost of the information across a number of different projects.

For example, the task analysis information may be useful when performing ergonomic audits for the proposed new facility that CLS is considering building. The social context information can be used as a starting point for human resources to improve management and staff understanding. Finally, portions of the questionnaire could be reused in the future to determine if ergonomic interventions are effectively reducing musculoskeletal discomfort in the workplace. CLS has obtained information that can be used in a number of different manners, to improve a variety of projects, and this information should be used to its maximum potential.

Not to be forgotten the idea of the social context of an organization affecting a project. This is very important item to consider and will be addressed throughout this document when there are situations that relate to this concept, as it is a serious issue that can significantly change the effectiveness of the training course.
Chapter 4 – Objectives and Goals

In the last chapter the needs assessment process was explored and it was demonstrated how this process was applied at CLS. Now that there is a more complete understanding of the needs of the employees at CLS this document will now shift focus onto the processes of developing goals and objectives for those people taking part in the training course. This is performed by once again exploring literature pertinent to the development of training courses and is followed by a description of how this process was applied at CLS. In the summary the important points to consider from this chapter are reiterated.

4.1 Literature Review

Upon completion of the needs assessment, the training course designer must determine the specific goals or objectives of the training course. By having a complete understanding of the hazards associated with the job, the training course designer is able to more accurately target hazards they wish to control through the training course. Targeting specific hazards means specific goals or objectives must be written, the importance of which is described in the next section.

4.1.1 Specific Goals or Objectives

Many training courses move from performing a needs assessment to developing the training methods without spending time developing the learning objectives or goals\textsuperscript{92}. As a result, a training course may fail when there is no clear objective to
give direction to the learning activities that are being developed. For example, a training course designer often assumes that the objective of the course is to present information to the people taking part in the course without necessarily having any specific goals. What is more important than presenting information en masse, is what the target population receives. People in a training course need specific knowledge of a hazard and techniques to reduce exposure to a hazard, in order gain useful information from a course. Training literature states that in order to achieve specific goals the training course must have specific objectives determined during the design of the training course.

In order to ensure that the target population receives an effective training course, the developer needs to use the information garnered from the needs assessment to identify specific training objectives. Examples of specific objectives in training course design will be identified in the section 4.1.2 of this literature review.

Not only should a training course have specific objectives it should also include an overall mission statement or goal of the training course. By documenting the specific objectives and overall goal there is now concrete targets to work toward while developing the learning activities. Clear, decisive objectives help to frame the learning activity into a sequence that is logical, ensures that the necessary resources needed are understood and determines the topics to be
included or emphasized\textsuperscript{97}. The objectives of the training course in effect become the outline for the development of the learning activities.

4.1.2 Types of Objectives

With the importance of having specific objectives outlined in the previous section, the next question becomes what type of objectives does a training course designer use. As was briefly mentioned in chapter 2 objectives typically fall under three broad categories: information objectives, attitude alteration and skill achievement. Some training course literature also states that modifying individual behavior is its own distinct objective\textsuperscript{98}. It should be noted that a training course will often have multiple objectives and that the objectives do not need to come from the same category. These four types of objectives will now be discussed along with an example of each type of objective.

4.1.2.1 Information Objectives

While all training courses impart information to the learner, an information objective is more specific. In the context of a health and safety course an information objective imparts knowledge of risks, hazards and their implications for human health and safety\textsuperscript{99}. This may be information such as the health hazards to humans from solvents.

There are many examples of information objectives within an ergonomic context. A specific example could be information on the health hazards related to repetitive motions that are performed during a typing task or the health risks that
a person is exposed to when they sit in a poor posture such as when they are working at a monitor that is too low. Information objectives give the learner specific knowledge but not necessarily the tools or skills to avoid the hazards.

4.1.2.2 Attitude Objectives

As suggested by the title an attitude objective aims to change, reinforce or have an impact on what a learner believes, which may change a workers behavior which is discussed in section 4.1.2.4. By changing a workers attitude it allows learners to move beyond their own barriers to allow them to use the newfound knowledge and skills that also may have been part of the training course. This can be a most difficult goal to achieve, as people are often very reluctant to change beliefs that they hold.

An example of typical attitudes that may be addressed by a training course include changing the idea that accidents and injuries happen to only careless or lazy workers. Alternatively a belief may be that an organization is only committed to increasing production and therefore safety will be at the cost of production goals. Changing these beliefs may be very difficult so it is important that commitments made during the training course are performed by the organization promptly to reinforce the fact that the organization is committed to a course of action.
4.1.2.3 Skill Achievement Objectives

Skill achievement objectives aim to ensure that a training course participant is able to carry out specific tasks that they will be required to perform on the job. Typically these skills are individual technical skills such as safe lifting procedures but may also include group action skills where participants are required to work as a team.

There are many specific examples of skill achievement objectives. These skills could include the ability to correctly adjust the features on an ergonomic chair such as the seat pan height, lumbar support, seat back angle and height of the arm rests. Another example might be the ability of a nurse to safely roll a comatose patient without strain on the back when changing bedding.

4.1.2.4 Behavior Objectives

Behavior objectives are often grouped in with attitude objectives but for the purpose of this paper it will be considered a separate objective. The intention of a behavior objective is to change more than what a worker believes or is capable of doing but to change what a worker actually does while on the job.

For example, in hospitals nurses often perform lifts on their own that should either be performed with extra physical assistance or through the use of a lifting device such as a sling lift. It is often the case that the lifting devices or extra assistance is available and that the nurses may understand the risks to their health by performing these lifts yet they perform the lift regardless. A behavior
objective would aim to increase the number of nurses that use the mechanical lift or ask for assistance when performing these types of lifts.

4.2 Calgary Laboratory Services

In the previous section it was shown that having specific objectives for a training course is very important. By successfully achieving these objectives the overall goal or mission statement of the training course will be met. In addition, it was demonstrated that the objectives of a training course can come from any or all of the categorized types of objectives when trying to meet the overall mission statement of the course.

In this portion of the chapter the overall mission statement of the training course is developed. This will be followed by the selection of objectives that were selected to satisfy the mission statement of the course. The decision to select each objective and the mission statement is a result of the information gathered from the needs assessment process that was performed in chapter three and feedback from CLS management.

4.2.1 Mission Statement

The overall problem with microscope use at CLS is the high rate of musculoskeletal discomfort and pain present in the staff performing this task. This problem is also demonstrated in the literature as was shown in previous chapters. Musculoskeletal pain and discomfort can lead to injury perhaps forcing a valued staff member to miss work for an extended period of time, which would
be costly for the individual in terms of the discomfort itself, the impact on other areas of their life and possible loss of pay. For the organization there is a cost in dollars due to finding replacement staff and increased Workers Compensation Board premiums and the failure to uphold their mission statement of the Environmental Health and Safety department to provide a healthy and safe working environment.

As a result a broad mission statement for the training course was selected to allow specific objectives to be developed. Using the information gathered during the hazard assessment and population profile, and then placing that information within the social context at CLS, allowed a presentation and discussion to place with the Environmental Health and Safety staff. From this discussion a mission statement was selected to address the concerns that management wanted addressed and that staff identified and research identified in the needs assessment. The mission statement for the CLS training course is:

"Provide CLS microscope users with the knowledge to recognize ergonomic risk factors that are present in the workplace and reduce these risk factors through the use of basic preventative techniques."

The high rate of musculoskeletal pain and discomfort is the primary issue that needs to be addressed when selecting objectives and goals for the training course. With this as the overriding concern the course designer must then select
objectives and goals that ensure that the microscope users are able address this issue upon completion of the training course. Each objective and goal needs to directly relate to the overriding issue present in the workplace.

In the next section the objectives of the training course will be detailed. These objectives will allow the staff at CLS to satisfy the mission statement of this training course. They will also describe why that specific objective was chosen.

4.2.2 Objectives

The objectives for this ergonomic training course will become the different parts or sections of the course. The objectives that have been selected vary in the type of information that they are conveying to the learner. This means that some of the objectives are skill objectives, some are information objectives and others try to modify the behaviors of the learners.

There are six general objectives in the training course but, as the importance of having specific objectives was outlined earlier in this chapter, each general objective has two or three specific sub-objectives.

4.2.2.1 Ergonomic Background Material

The purpose of this objective is to provide an understanding of the background material needed to understand the concepts that will be presented later in the training course. To do this there are two specific objectives that must be met, which will now be presented.
• Learners will become aware of basic ergonomic terms such as repetitive strain injuries, risk factors and ergonomics.

• Learners will develop basic knowledge of human anatomy by understanding the functioning of the muscles, tendons, ligaments and bones.

Without this information it would be difficult for the course participants to understand the terminology that will be used during the training course. This information is considered the foundation from which an understanding of the rest of the course material can be based. Without this material there is no common language that the course trainer and participants can use when discussing the material. While providing this material can use valuable time during a training course the course may fail without the foundation for learning.

4.2.2.2 General Risk Factors

The purpose of this objective is to present the general risk factors that are present in the workplace. There are again two sub-objectives that need to be met to satisfy this non-specific objective.

• Learners will understand the different general risk factors such as body position and frequency of movement that are present in the workplace.

• Learners will understand how these risk factors interact to cause pain and discomfort and possibly injury.
This objective is the next step in providing microscope users with an understanding of how risk factors can impact their health. Now that a common language has been developed it is possible to describe the issues in a general nature so that participants can begin to understand the different types of risks that may be present in the work environment. The understanding of general ergonomic risks will allow the users to more easily understand the next sections where specific risks in their work environment will be identified. As a result this objective acts as a bridge to a more detailed understanding of risks factors in the microscope work environment.

4.2.2.3 Microscope Use Hazards

The purpose of this objective is to take the background information that was presented as apart of the previous objectives and apply it to the learners work environment. To accomplish this there are two objectives to be met.

- Workers will be made aware of information on microscope ergonomic risk factors present in the literature, such as rates of injury and specific body parts susceptible to injury.
- Learners will understand specific body position and movement frequency risk factors that are present in the workplace.

Now that a general understanding of risks has been developed it is possible to apply these principles to a specific working environment. This objective ensures that participants are able to apply their general background knowledge to their own environment. Without the development of an understanding of the specific...
risks in the microscope work environment the users may not be able to make the leap from an understanding of general risks to the identification of specific risks. Without the ability to identify specific risk factors the course participants will not be able to determine which mitigation strategies suitable for use in their work environment. Therefore it is crucial that the participants be able to identify the risks present in their work environment.

4.2.2.4 Workstation Adjustment

This objective will begin to give the skills necessary to reduce the ergonomic risk factors that are present in the workplace. It will allow them to perform basic workstation modifications on their own. There are three specific adjustments the learner will need to be able to perform.

- The learners will understand how to correctly adjust the chairs present at CLS, including seat pan height and angle, seat back height and angle in addition to the adjustment of the arm rests.
- The learners will understand the correct position and heights of a monitor, keyboard, mouse and writing area at their workstation.
- The learners will understand the correct set up and positioning of a microscope at their workstation.

This objective gives the participants the tools to begin mitigating risks in their work environment. The previous objectives purpose was to develop an understanding of ergonomic risks and how those risks are present in different work environments. This objective ensures that users can address the identified
risks in a manner that is effective and safe. Without the development of these tools there is little chance of there being an improvement in the work environment. In essence without the development of these skills the entire training course will fail to provide participants with the ability to achieve the selected mission statement.

4.2.2.5 Behavior Changes

The purpose of this objective was to address hazards that may not be reduced through work area modification or to further reduce those hazards that were focused upon during the work area modification objective. There were five objectives that were needed to satisfy this requirement.

- Learners will understand the importance of rest breaks and be able to apply a break schedule that is suitable to staff and management.
- Learners will understand the importance of job rotation and will be able to determine a job rotation that reduces their exposure to ergonomic risk factors.
- Learners will understand the importance of taking micro-breaks regularly during a shift.
- Learners will make a list of changes that need to be made to their workstation and will be encouraged to set target dates for completion of these changes.
- Workers will be provided a reminder sheet that they can place in their workplace to remind them of basic ergonomic principles such as workstation adjustments and micro-breaks.

By specifically addressing the motivations of the course participants it is hoped that they will be encouraged to make positive changes to their work environments through a change in behavior. Literature has shown that merely giving users the ability or tools to change may not be enough to ensure that workers are active in making positive progress\textsuperscript{104}. By specifically addressing motivations in the work environment that encourage change it is hoped that the training course will have a greater positive impact at CLS.

4.2.2.6 Resources Available

The final objective was one that was asked for by CLS. It was one that was deemed important as the Environmental Health and Safety department has had difficulty receiving reports of ergonomic problems in the workplace as staff often do not know who to ask for help from or who to go to in order to report a problem. It also was included to show staff what resources they could use to make their work environment safer.

- Learners will be told, and will be given a hardcopy document, containing the chain of people they should approach when trying to deal with an ergonomic problem such as the area safety representative, manager and health and safety staff.
• Learners will be given a manual containing the information discussed in the training course to assist them in making changes.

• Learners will become aware of materials usable to modify the work environment and will be shown the process that is necessary to go through if new materials need to be ordered.

The purpose of this objective was to ensuring that the participants have the information needed to assist them should they feel the changes they have made are not effective. The inclusion of this objective empowers the workers to continue making changes as required to positively impact their work environment should the initial information be insufficient in providing impact. It also demonstrates to the participants that CLS is interested in supporting the process by providing resources for continued change in the work environment.

4.2.3 Assumption of an Instructional Design Model

When developing training activities the course designer either implicitly or explicitly assumes a psychological model of training theory. In the 1950's and 60's behavioral learning theories were predominant\textsuperscript{105}. These theories looked to develop complete analyses of learning in terms of behavioral objectives. Cognitive training theory on the other hand looks to emphasize the structuring and provision of knowledge\textsuperscript{106}. Current cognitive research has also expanded to include concepts that motivation and beliefs may direct learning\textsuperscript{107}.
It may have been obvious when the structure of the objectives is read, that this MDP has been developed under a cognitive training theory model. The objectives were structured in a format that built upon a foundation of a common language and continued to build to the point where participants were given the tools to make change in their work environments.

This model was selected because of information revealed in the needs assessment process. This information was that staff members already understood the importance of making positive changes to their work environment and were eager to make those changes. What the staff required was the knowledge to make the positive changes in their work environment. As a result, the assumption of a model that stressed cognition was selected.

Motivation and cognition interact to influence behaviors\textsuperscript{108}. Staff members at CLS have three primary motivators influencing them to use the knowledge from the training course. First, they wished to avoid the discomfort they had been experiencing that was very clearly demonstrated in the needs assessment process. Second, staff members understand that the work environments can be modified and their workstations were responsible for some of the discomfort but they do not understand what changes to implement so there is a motivation to learn. Third staff members were motivated to do their job well and most felt that a reduction in their discomfort would result in improvements to their work. With the staff having three strong motivators to effect change it was felt that a
cognitive model that stressed the structuring of knowledge would result in the best chance of behavior changes taking place. This does not mean that during the training staff were not encouraged to implement change. It only means that the structure of the course used a cognitive model, as there were already strong motivators to implement change.

4.3.4 Management Staff Cooperation

During the selection of the mission statement and objectives there was no mention of the cooperation of staff and management that was determined to be very important in an earlier chapter. It would seem that during this portion of the process that the management and staff are no longer actively involved in the process of the course development. This is not the case. As discussed in chapter three, staff and management were actively involved in the process of determining the needs of the organization, through interviews, surveys and other means. The selection of the objectives is a direct result of work performed in the needs assessment process and therefore includes the input of both staff and management.

This is not to say that direct input or feedback of the two groups should not be sought during this stage in the development of the training course, only that the ideas of the two groups have already been included due to the process that was used. In fact, staff from occupational health and safety at CLS reviewed the selection of the mission statement and objectives. This allowed the organization to have input prior to the actual development of the training materials. In this
case the input was the approval of the selected mission statement and objectives as well as the addition of an objective that was not foreseen as a part of the needs assessment. The occupational health and safety department estimated that there would be suitable resources to complete a course with these objectives.

Although management had direct access to review the mission statement and goals, the staff did not. Their only input into the selection of the mission statement and the goals was their participation in the needs assessment. This was a weakness in the development of this course, which could have been avoided through the use of a number of different techniques, which will be discussed shortly. In this particular instance the independence of the researcher was relied upon in order to ensure that staff goals were effectively represented without influence from CLS. This is not an ideal situation although it was considered acceptable in this instance, as CLS did not request changes to the mission statement or goals as they were presented. These goals were the direct result of the data gathering process, which included questionnaires, and interviews with staff, which represented their opinions on what goal information was important.

CLS only requested the addition of one goal that would not inhibit the achievement of the other stated goals considered essential after the data gathering process was complete. Therefore in this instance this decision to
preclude a formal participation process was considered acceptable although it should not be encouraged as a suitable technique when others are developing training courses.

The decision to act as a surrogate for staff is not one that should be taken lightly. In this situation it was critical, as the importance of keeping the support of management was considered vital to the overall success of the project. By acting as a surrogate it was decided that the needs of staff could be effectively represented without negative influence on the final product.

A more effective technique than acting as a surrogate would have been to develop an ergonomics team to supervise the development of the training course. This type of action is supported in training literature. It is recommended that this type of team have equal representation of both management and staff. Not only would this type of committee allow both groups to have feedback into the process involved in the development of the training course, it would also further encourage cooperation and buy in into the process by the two groups. This cooperation and buy in was shown to be important in previous chapters.

It is important to stress that the lack of participation may have had an impact on the training course. As was discussed in chapter three a lack of cooperation at this stage in the course development may have a number of negative outcomes
on the course. The exclusion of staff from participating in this section of the development could be viewed by the staff as a lack of management commitment to the project. Staff may also feel that the course is a top down driven process with management having control over the course objectives. The combination of these two issues can result in a lack of buy-in from the staff members.

If management and staff had worked together on this portion of the development process it is likely that the level of acceptance of the training course would be greater. This is because the staff members are able to see how their views were incorporated into the course and would feel that management valued their opinions. Without the cooperation and participation in the selection of goals there should be other methods that are employed to encourage staff to accept the training course.

In this situation it was stressed to staff how their participation in the evaluation section will impact the changes made to the course. In essence approval of, or modification of the goals could still be undertaken later in the development process. This was not considered a replacement of a management-staff committee but an attempt to mitigate the negative effects of not having this committee.

A further discussion of why the course was developed in this manner will be undertaken in the chapter summary. In the future it is recommended that a
management staff supervisory group be employed during the development of training courses as is recommended by the literature.

### 4.3 Chapter Summary

The following sections will review the information presented in this chapter and will address areas where the recommendations from the literature were not met.

#### 4.3.1 Review

In this chapter the different types of objectives were outlined. This was followed by a discussion of the importance of having specific objectives when designing a training course, as without them the course may not address the needs of the learners that were found during the needs assessment process.

This was followed by the presentation of the objectives and mission statement for the CLS training course. Each of the six objectives was general in nature; in order to ensure that the training course had specific objectives each of the general objectives had two or three specific sub-objectives to guide the development of the training course. The mission statement, general objectives and sub-objectives gives the training course designer an outline to use as developing the actual course material as everything that is presented during the course should address the objectives in some manner. It was also demonstrated why each training objective was considered important to the overall process of supporting the mission statement of the training course. It was also shown that
the literature was not applied in the manner that was intended, which may have resulted in a weakness in the training course development process.

4.3.2 Conclusions

The primary issue identified in the needs assessment has to be addressed when selecting objectives and goals for the training course. Without the development of objectives that address this issue the training course may not succeed. In this project the issue was the prevalence of musculoskeletal discomfort present in the workplace. Each objective and goal needs to directly relate to the overriding issue present in the workplace or that objective is extraneous. In this project each objective was selected to build a foundation from which the mission statement of the training course could be realized. These were finesse decisions that needed to be made during the development of the objectives. The impact of these decisions will be further discussed in the concluding chapter.

During this chapter a weakness was found during the development of the CLS training course. The weakness was that staff members were not involved as fully as they could have been during the development of the course objectives. In this chapter a management staff supervisory board is identified as being an essential element in getting participation from all parties. The primary reason for not getting this type of committee together, was that the client felt the additional resources required for this type of group to meet regularly would be excessive.
When working with a client vendor relationship, decisions made by the client can impact the manner in which work is performed. In this case, a limit to the available resources was reached and the client wanted decisions made without the use of the recommended process in the literature. A compromise was needed, the client/management gave feedback and I represented the staff based on the information gathered in the needs assessment. This is the only occasion in the document where it was necessary for the researcher to represent the employees and therefore the independence of the researcher was considered vital. If there were no independence of the researcher it would seem that staff did not truly have input into the selection of objectives, which could result in the failure of the training course.

As CLS did not challenge the goals or objectives as they were presented and the objectives were selected as a result of information gathered directly from the staff, this compromise was considered an acceptable decision in this particular instance. This type of compromise should not be attempted in the future as serious problems can arise if the client pressures the course developer to over represent their objectives in the training course. These problems with staff buy-in were listed in the body of the chapter. An attempt to further mitigate the issues that were raised as a result of acting as the surrogate for staff was to stress the ability of staff to influence the course at the evaluation stage. This was also not considered a suitable alternative.
If theory cannot be applied to a real world situation in every circumstance then the theory needs to develop further. In this instance the client prevented theory from being applied and decisions were made to attempt mitigate the effects of straying from the prescribed theory. However, I recommend that the training course designer attempt to achieve what the literature recommends, or at the very least understand what impacts ignoring the recommended stages of training course development may have on the final product and attempt to mitigate the negative consequences.

The impact of this exclusion of prescribed theory cannot be measured however some possible outcomes include; interpretation of staff that management is not committed to the course, interpretation by staff that the development process is totally driven by management, and a lack of buy-in to the training course. These issues could result in the failure of the training course developed for CLS. These issues further add to the social context under which the course is being developed. If the staff or management begins to not buy-in to the training course design then it will not matter how effective the training course may be. Without the support of both management and staff the training course will fail.

In the case at CLS, it is not thought that the exclusion of the staff from active participation was detrimental due to their significant involvement in the needs assessment process. It should be noted that there might have been additional information or input that resulted from a collaboration of management and staff.
It may have also been the case that collaboration would impact the level of buy in to the training course. While the end product in this project seems to be a success it is impossible to determine if the project would have enjoyed greater success. Also it seems be very unlikely that the collaboration in a positive environment would have had any type of negative impact on the process. As a result it was discussed with CLS that this exclusion should be avoided in the future and a committee of staff and management to supervise the development of the training course was recommended as a process to avoid this error in the future.
Chapter Five – Developing the Learning Activities

Now that the goals and objectives of a training course are determined, the training course developer can actively begin the development of the training course. The difficulty in designing the course is determining how the instructor should best impart knowledge to the learner. The techniques used to impart information to a learner have a large impact on how well the information will be used and retained by that learner\textsuperscript{110}. Furthermore, the technique that will best benefit retention in a given circumstance is not always clear as it is influenced by many factors\textsuperscript{111}.

It becomes very important to consciously determine how the learner will receive the information and resist the temptation to simply give the learner a mass of information, as this is not an effective way of having the learner achieve the goals that have been chosen. In this chapter types of training courses and learning techniques will be explored. In addition, the reasoning behind the selection of specific techniques for use at CLS will also be outlined.

5.1 Literature Review

A training course designer should understand the types of goals that have been decided upon and select a learning technique or techniques that gives the learners the best opportunity to achieve those goals. When specifying the
activities or media to be used during instruction, there are many options available for the course designer, which will be discussed later in the chapter.

The decision to use one learning technique over another is a decision that is influenced by many different factors. These factors include the type of objectives selected, training needs of the learners, resources of the organization and the mental and physical make up of the trainee group.

In the following sections there will be a discussion of the contents of a training course. There will also be a discussion of how to ensure the training is successful, types of training techniques and how the resources of the organization may also impact the selection of training techniques.

5.1.1 Contents of the Training Course

Earlier in this paper it was said that a needs assessment is required to determine the objectives of the ergonomic training course. The same needs assessment lends valuable information to the course designer when determining the contents of the course. By understanding what is lacking from the learners' education, the course can be better tailored to the learners.

There are many different times that training, in industry, can be given, which can be divided into several groupings. The two most common times training is given is pre-employment training and continuous training\textsuperscript{112}. Pre-employment training takes applicants and gives them the skills needed to perform a job prior to
beginning in the workplace. Continuous training involves employees already involved in the workplace.

One of the following three training methods are generally used in both training situations; on the job training, job rotation, in class training or a combination of the three\textsuperscript{113}. These training methods could be applied in many different industries.

Regardless of the training method used or the time training is given, courses are either classified as general awareness courses or as job specific training\textsuperscript{114}. In addition to using the needs assessment, several factors play a role in determining whether general awareness or job specific training is required. These factors include:

- The nature of the task the staff member is performing,
- The type of tools, equipment or processes involved and,
- The length of time the task is to be performed\textsuperscript{115}.

Typically as the task, tool, or equipment becomes more specialized or the length of time the staff member performs the task increases a specialized course will be more beneficial to the learner. Although this does not mean that the staff member will not benefit from a course designed to provide general awareness training. As often both general and specific training are required to provide an
employee with all the skills necessary to safely perform their job. There will now be a brief discussion of these two types of training.

5.1.1.1 **General Awareness Training**

General awareness training involves providing employees with information about the hazards involved in performing their jobs. This type of training should include information pertaining to the following concepts\(^\text{116}\).

1. Types of musculoskeletal disorders associated with the type of work being performed.
2. How ergonomic risk factors may contribute to musculoskeletal disorders.
3. How it is possible to prevent the disorders from occurring.
4. The process that should be used when reporting the symptoms associated with these disorders.

5.1.1.2 **Job-Specific Training**

Job-specific training applies specifically to the job the worker performs. This type of training should involve the following\(^\text{117}\).

1. Hands-on training before beginning a new job,
2. Proper use of equipment and tools,
3. Instruction on proper lifting techniques,
4. Workplace hazard identification,
5. Correct methods of work tasks such as sitting, standing, bending etc.,
6. The proper use of protective equipment.
5.1.2 Ensuring Training is Successful

Regardless of whether general awareness training or job specific training is provided to employees or prospective employees, training course designers should ensure that the learners are convinced that the training is important to them, that the learners are actively involved in the training process and appropriate training methods and materials are used\textsuperscript{118}.

5.1.2.1 Importance of Training

If employees are not convinced that training is important they are less likely to participate and hence will be less likely to achieve the objectives and goals of the course\textsuperscript{119}. Some methods that are effective in convincing staff of the importance of training include:

- Explain the goals of the training course,
- Explain the importance of training,
- Give training that is relevant to the workplace,
- Keep the training simple and thorough,
- Frequently summarize the main points and goals of the training.

5.1.2.2 Involvement in Training

If employees are actively involved in the training they will be more likely to gain the skills taught at the training course\textsuperscript{120}. Examples of how learners can be kept actively involved in the training process include:

- Encourage creative thinking,
- Encourage discussion and questions,
• Train under different conditions,
• Establish personal relationships with participants during training and,
• Ask trainees for comments on the material presented.

5.1.3 Training Techniques

When selecting techniques and materials for the training course, the type of job, the learning capacity of the employee, the duration of the course, the duration of the job, and the type and severity of risks should all be considered\textsuperscript{121}. Some effective training techniques include:

• Lecture
• Discussion
• Tutorial
• Self Instruction
• Programmed Book
• Materials Instruction
• Medium Instruction
• Laboratory\textsuperscript{122}.

Some adult educators consider these eight techniques to be the basic modes of instruction and that other modes of instruction are either the same type of instruction with a different name or alternatively a subset of one of these modes of instruction\textsuperscript{123}.

It would take much time to educate the reader on the advantages and disadvantages of all of the possible modes of instruction that could be used or to determine if other modes of instruction are valid in their own right. This paper will provide the mode or modes of instruction that were selected for use at CLS and will provide an explanation of these modes along with an explanation of why this
mode of instruction was the most appropriate for the situation. If information on
the other modes of instruction is desired refer to The Complete Book of Training,
by Mayo and Dubois, which provides summaries of other modes of instruction124.

5.1.4 Resources of the Organization

Developing training courses can be a costly endeavor for an organization. Costs
to an organization may include material costs for workbooks or reference
materials, loss of productivity while staff take part in training, consultant fees,
rental cost for space or projection units and on going costs to keep training
active.

It is therefore not surprising that the resources of an organization may not be
able to provide what would be considered an optimum training course in a given
circumstance. In this situation it must be determined what is the best
compromise so that the staff receive the best possible training with the resources
the organization has available to them. This compromise may be thought of as
determining what competencies are most important for the organization for which
the training is being designed125.
There is no easy method to use when determining this compromise. Some possible methods to use when considering a compromise due to a lack of resources may include:

- Ranking the goals of the training course and training only the most crucial,
- Using a different training technique that is more cost effective,
- Providing the training to those who are at highest risk\textsuperscript{126}.

Presumably there are techniques that can be used when modifying a training course based on the resources of the organization, however they were not found in the literature reviewed for this document. The important point is that there must be thought put into what compromises are being made so that the trainer is still able to provide an effective course to the participants. If these compromises are not thought through the course developer is at risk of developing a course that does not achieve any of the objectives that were identified by the needs assessment or alternatively the course may not be implemented, as it does not consider the limitations of the organization.

### 5.2 Calgary Laboratory Services

This section will outline the type of training that was selected and will also outline why techniques were selected for the training course. It will also outline the strengths and weaknesses of those techniques and why the techniques should make the training successful. There will also be a discussion of how the techniques were used to achieve the objectives discussed in chapter four.
Finally, there will be a discussion of the compromises that had to be made as a result of limited resources at CLS.

It will be valuable during the reading of this chapter to refer to Appendix 6 and 7. Appendix 6 is the Employee Reference Manual that was developed as part of the training course. Appendix 7 is the actual training course with speakers' notes. Having these appendixes on hand will allow the reader to see how issues that are raised in the discussions were implemented in the training course and reference materials.

### 5.2.1 Type of Training

The type of training at CLS was clearly determined at the beginning to be a combination of General Awareness training and Job Specific training.

Information from the informal interviews held during the task analysis and during the formal interview process demonstrated that there is little awareness among the staff regarding musculoskeletal disorders, ergonomic risk factors, prevention of disorders and the process to report issues or hazards within the workplace. Supervisors also expressed frustration at the lack of reporting by frontline staff concerning musculoskeletal disorders in the workplace. Furthermore, the task analysis revealed a lack of skill with regard to proper use of provided equipment, correct methods of workstation setup and organization, and poor use of available assistive equipment. These needs that were discovered meant that any education program would need to cover a great deal of varied information.
5.2.2 Techniques Selected for Training

Earlier in the chapter a variety of training techniques were outlined. These techniques included lecture, discussion and tutorial/student activity.

5.2.2.1 Lecture

Lecture is probably the most common instruction technique that is used. Lecture is instructor centered and presents information in a one-way type of communication with the learners held within a passive role\textsuperscript{127}. Research has indicated that the more active the learner is, the more effective the learning and the more passive the learner is, the shallower the learning will be\textsuperscript{128}. This is clearly the primary disadvantage of the lecture technique.

The primary advantage of using the lecture technique is that it is a very effective manner of communicating considerable amounts of information in a short period of time\textsuperscript{129}. As was discussed in the previous section it was immediately evident that there would be a considerable amount of information that needed to be communicated to the participants in the course. Due to this large amount of information the use of lecture was considered key, although the disadvantages would try to be offset by the use of more active learning techniques that are discussed in the next sections. By reviewing Appendix 7, it is shown that there are many slides that are given in lecture format with little or no active learner involvement, although they do provide a great deal of information. As all lecture material may not be retained the employee reference manual was developed to
allow the participants to have access to the information upon completing the course (See Appendix 6).

5.2.2.2 Discussion

Discussion was a more active training technique that is used in the training course. The primary advantage of using discussion is that the learner becomes more active, which encourages deeper learning and it is effective for exploring ideas\textsuperscript{130}. The primary disadvantage of discussion is that the exploration of a concept or idea can be lost if the discussion does not take place within some form of structured format\textsuperscript{131}. The instructor must ensure that they keep control over the discussion and facilitate the exploration of the idea. As discussion may take more time to explore an idea, which may be a limitation the training course designer is trying to work within.

In the CLS training course there were regular slides throughout the presentation that were review slides. During these slides the class was encouraged to determine what ergonomic risks were present in the picture and how these risk factors could be addressed. These slides also acted as a summary to the section that had been completed and encouraged the learners to apply the information that was just disseminated. In order to facilitate discussion the students were encouraged to apply the example to their own work environment and discuss how the concepts that were discussed could be applied in their work area.
5.2.2.3 Tutorial/Student Activity

A student activity encourages learners to apply information they have been given to a predetermined problem. This type of learning technique encourages the participants to be very active in the learning process. Student activities are considered one of the most effective learning techniques if employed correctly.\textsuperscript{132}

At the end of the formal lecture and group discussion section the participants at the CLS training course were given mock-ups of incorrectly adjusted workstations and were divided into two groups. One group would adjust their workstation for the tallest person in the class and the other group would adjust the workstation for the shortest person in the class using only materials available in the training room. Upon completing the activity each group would then critique the other group’s set-up. This activity was established to ensure the students would have at least one chance to adjust a workstation with the instructor present for feedback and the group could also see how different statures affected the set up of the workstations.

5.2.2.4 Choice of Modalities

The choices of these training modalities is a result of the amount of time allotted for the training course, the amount of material that needed to be covered and the inclusion of techniques to ensure that participants retained the material. None of the literature reviewed during this project outlined a method to determine which modalities should be used when developing different types of training courses.
Instead each text typically gave the advantages and disadvantages of each type of training modality, which were outlined in the preceding sections. It was the efforts of the researcher to provide a balance of different modalities in order to mitigate the weaknesses of each individual modality. By employing different training modalities it was hoped that the strengths of each modality were best represented resulting in the maximum retention of the presented material and the overall success of the training course.

For example lecture was selected, as it is an effective means of providing a great deal of information. The disadvantage is that this modality does not encourage retention of material. Therefore tutorial was also used to ensure participants were provided time in a more active learning environment that was more conducive to the retention of key concepts. By blending the modalities to use the advantages of each it was hoped that the participants received a better learning experience.

5.2.3 Ensuring Training is Successful

Section 5.1.2 discussed how to ensure that a training course is successful. The two main points that are discussed are ensuring that employees are convinced about the importance of the training and ensuring that employees are involved in the training. The next two sections will demonstrate how the microscope training course was intended to achieve those objectives.
5.2.3.1 Importance of Training

There were a number of elements listed in section 5.1.2.1 that were considered vital to ensuring that employees found the training course important. The CLS training course is designed to include these elements in a number of ways. The goals of the training course are given at the start of the course and employees are encouraged to keep in mind whether the course met those goals. Describing the types of injuries that can occur and illustrating the risks present in their workplace demonstrates the importance of ergonomic training and how that training is relevant to their workplace. The training is kept simple by following a common structure throughout the course of describing injuries that might occur, the risk factors for that injury and changes that can be made to address the risk factors. This structure is repeated throughout the training course for each body part. Finally, the review slides ensure that the important points from each section are summarized and the practical exercises further reinforces this information. By following these guidelines it is hoped that employees understand the serious problems that could arise if this information is ignored and also understand what information is necessary to remember in order to avoid the risk factors.

5.2.3.2 Involving Employees in Training

There were a number of elements listed in section 5.2.2.2 that were considered vital to keeping employees involved in the training process. A number of these elements are used in the CLS training course. Creative thinking was encouraged in the student activity section when the participants were expected to set up a workstation based on materials present in the training room. These materials
were placed in the training room on purpose so that students would have the correct resources but they were forced into a situation where they needed to determine what materials were useful.

Discussion was encouraged during the training at each review slide. Training was performed under different conditions by combining lecture, discussion and student activities. Students were asked about their perceptions of the course through the use of the feedback questionnaire that is discussed in chapter six. Finally, the size of the class was kept fairly small, to ensure that people felt more comfortable participating in group discussions. It was hoped that by employing these methods the participants would feel involved in the training process.

5.2.4 Obtaining the Objectives

During the course of the training course development six general objectives were selected, which are outlined in chapter four. The objectives were developed to ensure that the course would be designed with a direction. The following material will demonstrate which section of the training course was designed to satisfy each objective.

Objective one was to have the participants develop an understanding of relevant ergonomic background material including definitions of basic ergonomic terms. The design of the course aimed to achieve this objective through the use of the lecture material and a summary slide where participants were asked if there were questions about the material. This material, while important, was not considered
the most vital to developing the skills and behaviors the training course was trying to foster. As a result only a small portion of the overall training course time was spent trying to achieve this objective and alternative learning methods were not employed.

Objective two was to have the participants understand the general risk factors that are present in the workplace. To achieve this objective lecture material on a mechanism of injury model was described and information on the general risk factors was also given in lecture format. Similar to objective one this information was not considered the most important of the objectives, and limited time and methods of instruction were spent on this objective.

The third objective was to demonstrate the specific risks of working in the microscope work environment. To achieve this objective a combination of lecture material and student discussion was used. First the risks in the work environment would be shown during the lecture material. This would be reinforced with a discussion and review of these risk factors. Participants in the course would also be encouraged to provide examples of the specific risk factors that were discussed and whether they are present in their work environment.

The Environmental Health and Safety client considered the fourth objective one of the most important objectives. It was to ensure that participants in the training course could make changes in their work environment to reduce their exposure
to ergonomic risk factors. All three modes of learning that the course contained were used to ensure that participants would be able to make these modifications to their workstation. First, lecture material on workstation modification was given. Second, this material was reviewed and discussed during the summary slides and the participants were encouraged to identify the difficulties they may have applying this information to their own environment. Finally, the participants were asked to apply the skills they had been discussing in the student activity session that took place at the end of the class. Upon completion of this activity the participants further discussed issues that were found when they attempted to apply the information.

Changing the attitudes, and thereby the behaviors, of the participants to include safer work practices was the fifth objective of the training course. Where the other objectives may have numerous slides included in the course, this objective had very few. Instead the instructor needed to constantly address the importance of making changes to the way participants worked. This was supplemented with three lecture slides that addressed the high rate of injury associated with microscope use and information about the types of discomfort reported at CLS. Evidence of the constant support of this objective can be seen in the speaker's notes included with the training course.

The last objective of the training course was to outline to the participants what resources were available to them within the organization and provide them with
ergonomic resource material. This objective was satisfied by providing the participants with a resource manual and lecturing the participants on the correct process to handle ergonomic concerns at CLS. Discussion about the process that was outlined for handling ergonomic concerns was also undertaken to ensure that staff felt comfortable with the process that was put into place.

5.2.5 Training Compromises

As was discussed earlier in the chapter there are compromises that must be made when theories are applied to real world situations. In training courses these compromises often have to do with the resources of the organization, as training can be an expensive endeavor. The training course at CLS is no different.

The primary compromise made in the CLS training course was the length of time the course lasted. It was decided by the client that a training course lasting longer than two hours would place too much strain on the departments sending staff to be trained. As a result, the length of the course was set for three hours and the methods used to complete the training were modified. Specifically, the lecture method of training was used as the primary method of training for some of the goals and objectives of the course, even though this technique has been shown to foster learning that is less deep than other modes of learning.

The other modes of instruction (discussion and student activity) were reduced to accommodate the timeframe. These two methods of training were reduced by
having them only support and reinforce the most crucial goals of the training course. It was felt that by making this compromise time requirements would be met and the course would still be effective for the participants.

5.3 Chapter Summary

The following sections will review the information presented in this chapter and will provide some conclusions that result from using this information.

5.3.1 Review

This chapter dealt with the active process of choosing a type of training and the training techniques that will best achieve the goals and objectives that were determined earlier in the development process. As discussed earlier the difficulty in designing a course is determining how the instructor should best impart knowledge to the learner as these techniques have a large impact on how well the information will be used and retained by that learner\textsuperscript{133}.

In this chapter it was shown that a training course designer must consider the type of training to be provided, the techniques that will be used, also ensure that the training is a success for those involved and that the organization can support the training course. The development of the training course becomes a balancing act where the goals of the course, resources of the organization and learners needs all must be considered. In addition the training course designer must employ techniques to ensure the training course is successful while selecting media and activities to work in conjunction with the training techniques.
During this chapter it is described why and how specific learning techniques were employed at CLS. The way in which the learning techniques were used only needed to be modified to shorten the length of time the course would last. This was to accommodate the expense of having staff miss work to attend the training course. Shortening the training course did not impact the types of media employed or change the techniques that were employed to ensure that the participants found the course valuable. It was also not thought that shortening the course would significantly impact the goals that were considered the most important for staff to understand and be able to apply.

5.3.2 Conclusions

In the review portion of this chapter summary it was stated that the design of a training course is a "balancing act", where different needs have to be accommodated. In all the literature that was reviewed for this project there was a great deal of discussion of training techniques, activities and media for use in training, but there was no specific framework given for choosing how the specific techniques that are to be selected. Hence the "balancing act" the training course designer must perform.

In this project learning techniques were selected and the course was designed (in essence the balancing act was performed) to the best of my understanding of training course design, and within the guidelines of any literature on the subject that was found. It should be noted that this was the first course I designed from
start to finish and this may have impacted the techniques I selected. I would conclude that a firm understanding and experience in using the elements of training course design might result in a course that provides learners a different and possibly superior learning environment.

At CLS, the development of the training course seems to be a success; as is demonstrated in the next chapters. However, during the process of constantly improving a course, which is also recommended in later chapters, CLS may wish to get the feedback of an experienced adult educator to determine if the most appropriate learning media and activities were selected. While the literature was followed and seems to validate any decisions that were made during the development of this course, it seems prudent to get further input on the training course as it has been developed.
Chapter Six - Conducting the Training

Now that the course has been developed, the first round of training can begin, although the training course should not yet be put into wide release within an organization. As discussed in the introductory chapter there is a need to run the training course to determine the effectiveness of the course. This initial training course or pilot course is used to invite the worker to have input into the training process that has been developed\textsuperscript{134}.

The purpose of the pilot course is to receive feedback directly from the people for whom the course is designed. The employee input into the training may result in increased motivation of the worker to have the course succeed and may also identify weaknesses in the training course as it has been initially designed. Without this pilot course, employee buy-in to the course may be weak and any weaknesses in the course may not be addressed, resulting in an ineffective program.

In this chapter there will be a brief discussion of the purpose of pilot courses and how feedback from employees may be gathered. This will again be followed by a discussion of how the process was undertaken at CLS.

6.1 Literature Review

When deciding that feedback from learners is a necessary part of developing a training course one must understand the type of feedback that will be generated.
Learners involved in a training course do not give objective feedback to the
course designer; they give their subjective perception of their experience during
the training course\textsuperscript{135}. Subjective information can only provide a partial view of
the training course, as learners in training courses are generally unable to
comment on the relevance of the information and the quality of the content.

The course designer should be using relevant information and have good content
if the steps for training course design listed in this document have been used.
However, if more objective evaluation of the course is necessary then other
sources of information are mandatory. This will be discussed later in the
document during chapter seven, improving the training course.

The primary advantage of this subjective evaluation is that the learners are the
non-experts. Therefore, they are the only people that can accurately describe
how effective the course was in getting them to comprehend the desired
objectives although there may be other procedures that could be used to
measure the course's effectiveness\textsuperscript{136}. The question then becomes what is the
best method to receive feedback from the people who have experienced the
training course. There are two main methods for collecting this information; one
is to interview the students, the other is to provide a questionnaire. These two
methods will now be briefly discussed.
6.1.1 Student Interviews

As discussed earlier, one of the primary evaluation techniques that can be used is a student interview. For this technique a group of four to eight students are assembled into a student focus group and are interviewed by the instructor, a colleague of the instructor or a peer of the students\textsuperscript{137}. There are a great variety of interview techniques that could be used to gather feedback from the learners; however, many researchers recommend some form of group interview so that students feel less intimidated by the process\textsuperscript{138}.

It is important that the interview is performed in a highly structured manner or the technique is likely to be ineffective\textsuperscript{139}. If the technique is undertaken in an unstructured manner it is likely to be biased picture of the groups' views, as most students will refrain from commenting.

There are many different interview structures that can be used, some as simple as having a matrix of good and bad points as they pertain to the teaching, content and delivery methods. The interviewer has each learner comment on each section in private (See Figure 6.1 below)\textsuperscript{140} and then records the majority views for further discussion by the group. The structure allows learners to comment in an unthreatening manner and the main concerns of the learners are both recorded and addressed by the group, although the interviewer could use virtually any structured technique.
Figure 6.1 - Possible Matrix for Structured group feedback.

<table>
<thead>
<tr>
<th></th>
<th>Good Points</th>
<th>Bad Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>About the Delivery Methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>About the Teaching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>About the Content</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.1.2 Questionnaire Feedback

The second approach to gathering feedback from the students is to use a questionnaire. The primary advantage of using a questionnaire is that feedback can be gathered from all or virtually all of the people involved in a course. The risk of using a questionnaire is that many people who rely on questionnaires do not appreciate the difficulty of developing an effective questionnaire to use as a tool to gather feedback from learners\textsuperscript{141}.

Some issues regarding the use of questionnaires relates to the technical aspects of questionnaire development such as whether the questions asked in the questionnaire are the ones that learners find relevant to the evaluation process. If learners feel that the questionnaire is not relevant, the responses given tend to be neutral and lack meaningful content for use in course evaluation\textsuperscript{142}.

Another issue when using questionnaires to gather feedback relates to how the results are interpreted, especially when the results are converted to some form of numerical value\textsuperscript{143}. The quantified results are only as valid as the subjective
opinions the learners express. It is very important that the results not be granted validity just because they appear to be objective.

Because it is not the purpose of this document to address every single nuance of training course design, recommendations for questionnaire development, administration and assessment will not be addressed. However there are many guides available for all levels of expertise when addressing this topic\textsuperscript{144, 145}.

6.2 Calgary Laboratory Services

In the literature review in this chapter the importance of gathering feedback from an initial pilot course was discussed. A pilot course can increase the "buy-in" from employees and also may identify critical weaknesses that had not been perceived by the training course designer. It was shown that this feedback is gathered in one of two ways namely, through interview and/or questionnaires.

In this portion of the chapter there will be a discussion of how these techniques were put to use during the course development process at CLS and the results of this process. There will also be a discussion of what recommendations for change resulted during initial assessment of the training course, although there will first be a discussion of how "buy-in" from the employees across the organization was attempted.
6.2.1 Employee Support for the Training Program

Discussion with Carol Becker from Environmental Health and Safety was key in determining how support for the training program would be gathered from across the different departments. It was decided that a strategy of including supervisory staff and front line staff from each department, in the first pilot course, would be attempted. It was decided that both staff levels would be included for two reasons.

- Supervisors would be asked questions concerning the new training course and should have first hand knowledge about the course or there would be a risk that supervisors would feel they had no input and may not support the training program.
- Front line staff needed to be included to ensure that these staff felt they were truly involved in the process as there had not been a staff work group included earlier in the development of the training course, only a questionnaire and limited numbers of interviews.

To include both staff levels Carol Becker at CLS requested that each department send at least one supervisor and one frontline staff member to the training course. For the most part this request was granted although some supervisors chose to forego the training and sent two frontline staff members instead.

By including both levels of staff it was hoped that the greatest amount of support could be generated. It was hoped that management and staff felt they had input
into the process through the use of the questionnaire and interviews. The results of the questionnaire indicate that both supervisors and frontline staff were pleased with the training course. Further results of the questionnaire will be discussed in section 6.2.2.2.

6.2.2 Assessment Techniques

Upon completion of the training course development there were discussions held with CLS on what strategies would be used to assess the initial pilot course. It was determined that a combination of interviews and questionnaires would be used. It was thought that by combining the two techniques the data from both would be able to be referenced against each other to assist in determining what changes to the course might be necessary. The Sections 6.2.2.1 and 6.2.2.2 will address the results from the two feedback techniques.

6.2.2.1 Interview Results

The interview process at CLS was unstructured, which directly contradicts the manner recommended in the literature review. Initially it was thought that there would be a discussion held with all 10 participants who took part in the training course. It was intended that the interview use a structured technique similar to the matrix that was presented in Figure 6.1. However, by the time the course was finished, general questions were handled and the feedback questionnaires were filled out there was little time remaining to hold a formal discussion about the merits and weaknesses of the training course. The lack of time was due to
discussions held during the training course taking longer than anticipated, combined with the need to have staff return to their work areas.

Instead an unstructured interview was held with Carol Becker from CLS and client feedback was gathered. Ms. Becker felt that the course was good and did not feel there were changes that were immediately required to the training course. She felt that changes may be required after more staff had taken part in the course and further evaluations had been received. As a result of gathering only unstructured information from the client, the interview process was not used in the evaluation of the training course. It is recommended that an extra 15 - 20 minutes be added to the course time to allow the instructor to perform a structured group interview.

6.2.2.2 Questionnaire Results

During the discussion of the questionnaire results, referencing the Evaluation Form that was given to the training course participants will be valuable. This Evaluation Form is available in Appendix 8. First the results of the first four close-ended questions on the evaluation form will be given in table format. This will be followed by a brief discussion of these results. There will then be a discussion of the six open-ended questions that were on the second half of the evaluation form.
In Table 6.2 the numbers of participants responding to each descriptor are shown next to the question that was asked. The descriptor that the participants indicated is located in the top row.

Table 6.2 - Close-Ended Evaluation Form Results from all 10 Course Participants in the Initial Ergonomic Microscope Training Course

<table>
<thead>
<tr>
<th>Question</th>
<th>Excellent</th>
<th>Good</th>
<th>Average</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How would you rate the course overall?</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. How effective was the course in achieving the stated objectives?</td>
<td>8</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. How would you rate the methods used to achieve the course objectives?</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. How would you rate the reference materials handed out during the course?</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
From the close-ended questions it appears that the participants were happy with the training course as it was presented. It should be noted that subjects responding to close-ended questionnaires tend to mark them more positively than they would assess other forms of evaluation\textsuperscript{146}. Question three demonstrates that the majority of the respondents felt that the course achieved the objectives that were stated at the beginning of the training course (8 of 10 respondents reported a score of excellent).

The remainder of the responses is split essentially evenly between excellent and good for the remaining questions on the evaluation form. As there are no questions where any of the respondents rated the course, achievement of objectives, methods or reference materials as average or lower, it was determined that there were no changes to the course that needed to be made as a result of the responses to this portion of the questionnaire. The client agreed with this assessment, feeling that there were no changes required as a result of the responses from this portion of the evaluation form.

In the next section of the course evaluation there are six open-ended questions the participants were asked to respond to. Each of the six questions was reviewed to determine if there was a common response from the participants on any of the questions. After reviewing the evaluation forms it was found that questions six and seven yielded six common responses from the ten questionnaires. Questions six and seven read as follows,
6. In your opinion what was the least effective part of the training course,
7. What changes would you make to improve the training course for future participants?

As mentioned six of the ten respondents had responses in common. The types of responses included requests for more "hands-on work", "demonstrations of physical exercises" and additional exercises practicing "the setting up workstations". As mentioned previously in chapter five, these types of learning techniques were shortened and applied to achieving only the most crucial goals to ensure CLS had the resources to provide the training to its employees. These common responses yielded two recommendations for change that should be applied to the training course and the client agreed that these changes were prudent. They will be further discussed in the next section.

6.2.3 Recommendations for Change

As there was no structured interview information that could be cross-referenced with information from the questionnaires, recommendations for change resulted from the questionnaires. The client approved all changes that resulted from the questionnaire. The changes that resulted from the initial course evaluation are listed in bullet form below.

- Adding more hands on exercises practicing the set up of workstations,
- Performing the physical exercises that were discussed during the course.
Performing these changes required the approval of the client at CLS. The primary impact that results from these changes is a lengthening of the time the course lasts. As discussed in chapter five the course was shortened in order to ensure CLS had the resources to provide staff the training course. These resources are primarily the ability to keep enough staff working in an area to complete necessary work. At this stage in the development process the course was reduced in time by approximately two-hours. Adding additional hands-on work and demonstrating the exercises is estimated as an increase of approximately 30 minutes, a compromise the client found acceptable. All changes made to the training course have been included in the copy of the course included in appendix 7.

It should be noted that the overwhelming majority of participants (8 of 10 respondents) reported the course achieved its goals without the addition of this material. Therefore these changes were made to increase the satisfaction of those people taking part in the course and to further reinforce the concepts of stretching and workstation set up. Future evaluation will determine whether these changes affect the manner in which participants rate the training course.

6.3 Chapter Summary

The following sections will review the information presented in this chapter and will address areas where the recommendations from the literature were not met.
6.3.1 Review

A pilot course is used to invite the worker to have input into the training process that has been developed\textsuperscript{147}. Employee feedback into the training may result in increased motivation of the worker to have the course succeed and may also identify weaknesses in the training course as it has been initially designed. Without this pilot course, employee buy-in to the course may be weak and any weaknesses in the course may not be addressed resulting in an ineffective program.

This chapter addressed the idea of gathering employee feedback. It was determined that there are two processes that can be used to generate feedback, interviews and questionnaires. Recommendations were made on how to employ both processes effectively.

It was then discussed how these processes were used at CLS. The interview was not used due to time constraints at the end of the training course, although in the future it is recommended that this technique be used according to the guidelines at the start of this chapter. Information from interviews may allow further refinements to the course that were not made evident by the information gathered from the questionnaire.

The questionnaire distributed to the participants generated interesting information. The feedback from this evaluation form saw employees requesting
more active learning processes that were purposely reduced due to time constraints, as a result of decisions made during the active development of the training course. Due to this feedback it was decided that, in future offerings of the training course, more hands-on workstation modification would be performed and the stretches and exercises would be performed during the training course. The client approved these changes.

CLS felt that the inclusion of these additional activities would not significantly change the resources necessary to provide the training course and would include these changes in future offerings. It is also recommended that CLS continue to re-evaluate the course to determine whether the two changes impact the overall impression of those employees that take part in the training course.

6.3.2 Conclusions

In the review section it is stated that structured interviews were not used to generate feedback as part of the pilot process, although this is a technique that is identified in the literature has being vital. The question then becomes why this process was not employed during the initial pilot course? The reason for this error is that sufficient time was not budgeted to fully present and gather feedback during the pilot course. Staff members involved in the pilot course had commitments outside of work, or needed to return to work to ensure that the required work tasks could be completed during that work shift.
An overly optimistic assumption was made that the training course and evaluation could be performed within a tight time frame, which did not consider the course running longer than anticipated. It was learned from this experience that the first presentation of these types of projects should budget time beyond the expected length of the course to account for unexpected events taking place during the training course. The error did however have some positive impacts in that it allowed for additional recommendations be made to CLS on the importance of piloting a training course.

While the primary purpose of using a pilot course was identified as generating feedback from the people for whom the course is designed; the secondary purpose could be said to allow the training course designer to understand how the course will actually run, something that was not stated in the literature reviewed for this project. Understanding how a course runs may mean that the course designer develops an understanding the true length of the course. Alternatively the course designer may develop an understanding of the type of questions that will be asked as a result of the information that is presented to the participants. I would suggest that receiving feedback and understanding how the course will run are purposes that are equally important to the training course designer.

CLS intends to use further pilot courses prior to rolling out the training course across the organization. This means that the lack of interview feedback from the
first pilot should not be detrimental, as sufficient time can be budgeted in the next pilot courses. It is recommended that CLS use the structured interview process identified earlier. This will mean that the interview data collected during additional sessions can be added to the feedback generated from the questionnaires in this session.

Furthermore, as CLS pilots the course further, the instructor should pay careful attention to the types of information being requested and length of time each session takes to perform. Having an instructor that is familiar with how the course runs will allow the instructor to better prepare for giving the course, and will also allow the course to be run in a timely fashion.
Chapter Seven - Evaluating Training Course Effectiveness and Improving the Training Course

Now that the initial pilot course has run and an organization is using the course regularly, a method needs to be developed to determine what effect the training course is having on the organization. The evaluation by the organization to measure the effectiveness of the course may be considered a more holistic approach than the previous stage where the employees were asked whether they found the course useful and if the course could be improved. This chapter becomes in essence an extension of chapter six where other evaluative techniques available to an organization are explored.

By evaluating the effectiveness of the course an organization is able to determine whether the training course has met the needs of the learners and client, and whether a course can be modified to more fully address the hazard or hazards outlined in earlier stages of course development. Without these steps an organization may continue to use a course that is not effectively addressing the issues that have been identified in earlier stages of the process.

As discussed earlier improving the program has been linked with evaluating the program effectiveness into a single chapter due to their close relation. It is again important to stress that these two theoretical steps or action items are separate components when designing a training course. They are only joined into a single
chapter to make it easier for the reader to understand how evaluations of the training course can result in improvements to the course.

There will be a discussion of the techniques that can be used to evaluate the effectiveness of the program. This will be followed by recommendations to CLS on how their organization may want to examine the effectiveness of the ergonomic training program. This section of the document will not outline methods that CLS used in the evaluation of the course, as this was not part of the initial Masters Degree Project proposal. It was felt however that the document would not be complete without a discussion of the techniques CLS could use to further evaluate the training course.

7.1 Literature Review

When considerable time, money and effort have been put into the development of a training course why does an organization need to expend further resources evaluating the training? Donald Kirkpatrick in his book Evaluating Training Programs (1998) suggests that there are three specific reasons why training programs are evaluated.

- To justify the existence of the department giving the training by demonstrating how the program contributes to the organization's goals and objectives.
- To determine whether to continue or discontinue a training program.
- To gain information on improving future training programs.\textsuperscript{148}
In his book Kirkpatrick also suggests the most common reason for evaluating a course is to gain information on improving a course. Regardless of the reason why the evaluation is being performed, there will not be a benefit if an evaluation is not well thought-out and does not address the reasons why an organization is evaluating a training course. Constantly improving a training course allows an organization to continue to improve and create value, as training is an investment in the future performance of employees. The next question becomes what process needs to be followed to properly evaluate a training program.

7.1.1 Evaluation Techniques

There is some agreement in training literature over the methods that are used when training programs are evaluated. These four agreed upon stages can be called:

- Reaction,
- Learning,
- Behavior,
- Results.

The next sections will explore the components of each of these evaluative techniques.

7.1.1.1 Reaction Evaluation

This is the technique where trainees evaluate the training course directly. As this was the major theme of Chapter Six information on using this technique will not be reiterated. It should be noted that this type of evaluation is the most
commonly used form of evaluation and that most evaluation programs do not move beyond this subject centered evaluation technique\textsuperscript{155}, the impact of which will be discussed later in this chapter.

7.1.1.2 Learning Evaluation

Learning has been defined within a training context as, "...the extent to which participants change attitudes, improve knowledge and/or increase skill as a result of attending the program."\textsuperscript{156}. Unless there is a change in attitude, increase in knowledge or increase in skill no learning has taken place. It is important to measure learning, as unless one or more of these learning objectives have been impacted there can be no change in behavior by the participants.

There are many different methods to evaluate learning such as printed tests, product evaluations, performance measures, and check lists, each having their own advantages and disadvantages\textsuperscript{157}. These methods can be either subjective or objective and can range from the simple to the elaborate. A common element of all these evaluative techniques is that they are generally more costly to an organization than reaction evaluative techniques\textsuperscript{158}.

7.1.1.3 Behavior Evaluation

Evaluation of behavior is an attempt to determine what happens when trainees leave the classroom and return to their workplace\textsuperscript{159}. In essence it is an effort to determine whether a person who has taken part in a training course has taken skills, knowledge or new attitudes and applied them to their work environment.
Without a positive change in behavior there will likely be very little measurable benefit that results from a training course\textsuperscript{160}.

As measuring a change in behavior can be more difficult and costly than measuring learning, the use of this evaluative technique is often considered prohibitive by most organizations. Although if no measure of behavior is taken an organization will not truly be able to determine whether the training is having the desired impact on the participants.

7.1.1.4 Results Evaluation

Perhaps the most important and difficult aspect of training course evaluation is determining what final results occurred as a result of attendance and participation in a training program\textsuperscript{161}. This results evaluation is the determination of whether the organization has in fact benefited from the training course. This is often a measure of whether the costs of implementing the training have been less than the financial benefit that resulted from the training course. It may also be a measure of other results determined by the training course designer.

Results can often be difficult if not impossible to prove, although there are exceptional situations where measures are easy to determine such as reduced injuries within an organization or increased sales by members that have taken part in the training course\textsuperscript{162}. Results along with the other evaluative techniques can provide valuable data for improving the design of a training course
There is no set of standard criteria that can be prescribed for measuring performance or results of training\textsuperscript{163}. What can be said is the decision to select performance measures reflects two key factors: first, what will be the intended use of the performance data, and second what are the priorities of the stakeholders\textsuperscript{164}. More will be said about results in section 7.1.3 where uses for evaluation of training beyond course improvement are discussed.

7.1.2 Using Evaluative Techniques

Determining what evaluation technique to use depends on what an organization wishes to know about the training program. The table below is adapted from the text Training for Impact\textsuperscript{165} which outlines the type of information gathered by each evaluation process and compares the cost to use each of the different evaluative techniques.
Figure 7.1 - Information Gathered from Each Type of Evaluation Technique and comparative costs to the organization.

<table>
<thead>
<tr>
<th>Information Required</th>
<th>Evaluation Technique Needed</th>
<th>Cost to the Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the participants like the program?</td>
<td>Reaction</td>
<td>Nominal</td>
</tr>
<tr>
<td>Did the participants learn the objectives of the training course?</td>
<td>Learning</td>
<td>Moderate</td>
</tr>
<tr>
<td>Are the participants applying the skills, knowledge and new attitudes in the work environment?</td>
<td>Behavior</td>
<td>Moderate to Expensive</td>
</tr>
<tr>
<td>In the application of new behaviors has there been any impact on the business?</td>
<td>Results</td>
<td>Moderate to Very Expensive</td>
</tr>
</tbody>
</table>

When an organization is determining what type of information is needed, they must also consider the costs of evaluation. When evaluating a course for results, behaviors, or learning, each of the assessment techniques listed previously will also need to be used or the information may not adequately depict what is lacking from the training course\textsuperscript{166}. This is the major reason why each level of evaluation is more costly than the last. An example of why an organization must use each of the evaluative techniques in sequence will now be given.

In this example an organization evaluates only the behaviors of the participants in a recent training course. The organization finds there has not been a behavior change and feels that there was no learning that resulted from the training course. This may be a false assumption. If the organization had also assessed
learning, they may have found significant learning that resulted from the course. This may have lead to findings that management did not support the information given in the training course and the participants were prevented from implementing changes.

Each level of evaluation builds on the previous technique by providing a more complete assessment of the training. By using all forms of evaluation, up to the point where the organization feels it has the information it requires, a more compete assessment of the training will result. The more detailed an evaluation is, the easier an organization may find it to make changes that are required in their training program.

7.1.3 Other Uses for the Evaluation of Training Courses

Evaluation procedures can provide reliable information on which future decisions about training can be made. Earlier in this chapter three reasons for evaluating training courses were given. These are not the only uses of training course evaluation.

Linking training to business needs and strategically implementing a program so that it yields measurable results to the organization are very possible and desired accomplishments. The key term in the previous sentence is the word "results". Many times results are mistaken for a return on investment, which usually does not capture all of the strategic goals of an organization.
Using a results measure is more holistic than a return on investment measure. This results measure provides a more accurate picture to the organization of the benefits of a training course. The assessment of four key areas of performance has been suggested, which takes the idea of results evaluation beyond Kirkpatrick's model of evaluation described earlier in this chapter. These areas of performance are:

- Financial perspective,
- Customer Perspective,
- Internal perspective and,
- Continual improvement\(^{168}\).

By using Kirkpatrick's model of training course evaluation and supplementing it by measuring results that include these areas of performance, a trainer will be able to better demonstrate how training solutions contribute to an organization. Information on developing more complete evaluative processes can be found in numerous sources\(^ {169,170,171}\).

### 7.1.4 When not to Evaluate Training Programs

Sections six and seven have discussed of the importance of evaluating training. It may seem that training should be evaluated to the fullest extent each time a program is developed. This is not true. There are six conditions under which the evaluation of training is inadvisable or should be modified\(^ {172}\). These conditions are:
- When a study that will provide useful information cannot be designed.
- When an adequate design for the evaluation cannot be implemented.
- When resulting information will be inaccurate or misleading.
- When the cost of an evaluation is greater than the potential benefit.
- When the sponsor of the evaluation is strongly motivated to prove or disprove something.
- When no action will be taken on the basis of the findings.

When one or more of these conditions is met, a training course designer should perform no evaluation or should perform only an evaluation that is feasible. If the designer chooses to perform a full evaluation, erroneous information may be generated or resources can be wasted, each may have a negative effect on the future of the training program.

7.1.5 Improving the Training Program

Perhaps the most important purposes of evaluating training are too improve the overall design of the training package for the situation it is being developed\textsuperscript{173}. An organization that evaluates the effectiveness of the course should be doing so with the intent of improving the course if deficiencies are found. If evaluation is performed and deficiencies are not corrected an organization is not using its resources effectively. Improving the program may require repeating some or all
of the stages that have been previously listed as a part of the course development. This cycle of regularly evaluating a training course and making changes in areas of deficiencies ensures that the training remains effective whenever the course is being used\textsuperscript{174}.

7.2 Calgary Laboratory Services

Chapter six outlined the reactive evaluative process that was put in place for the pilot CLS training course. In the previous sections of Chapter Seven other evaluative techniques are outlined and their value was described. In this portion of the paper recommendations will be outlined for CLS on how they might incorporate these additional evaluative processes into their ergonomic training course.

These recommendations are of course not crucial to the continuance of the training course, but rather are suggestions that CLS may use if they determine the costs are justifiable. The next sections will briefly outline methods that could be used to evaluate learning, behaviors and results. Reactions will not be included due to its inclusion in Chapter Six.

7.2.1 Learning Recommendations

Evaluating learning is important. As mentioned previously without some level of learning no behavior change is possible. When evaluating learning the purpose is to determine what knowledge and skills were added and measure how attitudes changed. The most common technique for measuring learning is a
printed test\textsuperscript{175}. These tests can be both pre and posttests, where a learner is evaluated prior to and following a training course. The printed test can also simply be an achievement test, where a specific level of knowledge needs to be displayed by the learner.

The current evaluative reaction testing technique used at CLS does not measure any level of learning generated by the training course. The benefit to CLS of implementing such a test would be to determine whether the training course as it is written is effective in imparting the training goals listed at the start of the training course.

Due to the resource restrictions involved with giving the ergonomic training course it is recommended that CLS only implement an achievement type testing procedure. The implementation of this type of test will impart information on the achievement of the training course goals. By only using an achievement test CLS will avoid the extra time required to perform a pre and post test procedure. If the resources become available at a later date, CLS may wish to begin a pre/post test system that will show the changes in learning that result due to participation in the training course.

Sample test items might include asking the participant to provide information on the correct height of the keyboard, mouse and monitor or asking a participant to identify ergonomic hazards displayed in a picture. There are many different
types of written test procedures that could be used, as long as the tests are
designed to determine whether the participants are able to achieve the goals
given in the training course. Some examples of these types of tests include;
multiple-choice tests were the participants select the correct response, long
answer tests and short answer tests where participants need to respond to a
question with various amount of detail.

7.2.2 Behavior Recommendations

The next step for CLS would be to determine whether changes in learning have
had an effect on behaviors in the workplace. Assessing behavior changes in the
workplace can be a more difficult procedure than measuring changes in
learning\textsuperscript{176}. Standard procedures for evaluating behavior changes include
interviews, survey questionnaires and observation. The process of evaluating
behavior changes can be complicated, difficult and time consuming if a formal
analysis is to take place\textsuperscript{177}.

This process may not be attractive to CLS due to the resources involved in
attempting an analysis of this type of change. However, literature recommends
an assessment of behavior changes even if the assessment is not scientific or
elaborate\textsuperscript{178}. The evaluation can be as simple as informal interviews with people
who have completed the training course or casual observation of employees that
have completed the training course. Using these informal observations and
interviews will allow management to have a feel for whether training is being
applied in the work environment.
This informal interview and observation process is recommended for use at CLS. The interviews and observation will cost little in the way of company resources and may identify reasons preventing or assisting behavior change in the workplace. These simple questions may be valuable in identifying other organizational issues that need to be addressed in order for staff to implement the training they received in the ergonomic training course.

7.2.3 Results Recommendations

Assessing results can be the most difficult but most rewarding measure to use when evaluating a training course\textsuperscript{179}. This may make it difficult for an organization with limited resources to evaluate a training course at this level. The literature review section identified situations where results evaluation can be less difficult. One of these examples is when a company measures a reduction in injuries, assuming they have a measures in place that already accurately assess injury reports and the cause of those injuries.

Taking the time to fully address the results of the training course as it pertains to the overall strategic goals of the organization may not be feasible at CLS due to limited resources, however, assessing a reduction of injuries by tracing injury reports and Workers' Compensation Board Claims is feasible with little expenditure of resources assuming CLS has an accurate reporting process.
CLS should begin tracking injury reports that are related to ergonomic issues within the workplace. Tracking these reports will allow CLS to determine the impact the training course is having as increasing numbers of staff within the organization are participating. The advantage of tracking these reports is that CLS will be able to determine the effect over time that the training course is having, and understand at what point the use of the training course is no longer affecting injury rates. When injury rates are no longer being affected, CLS may want to modify the training course or expend training resources on a different type of training.

When assessing injury rates CLS will also need to determine if there are other factors affecting the reporting of injuries. For example, the training course contains a section where a description of reporting an injury is detailed. This information may cause an initial increase in the reporting of injuries prior to seeing a reduction in injury reports. By tracking these types of statistics tangible results can be attributed to implementation of the training course.

### 7.2.4 Choosing Evaluation Methods

The selections of the preceding evaluation methods for CLS and for that matter the reactive evaluation techniques used in Chapter Six were almost solely chosen to keep the financial costs to a minimum. It is important to evaluate and make changes to a training course. If an organization does not have the resources necessary to evaluate a course and make changes the course will not
adapt and stay relevant to the organization. By using and recommending evaluation strategies that are effective yet inexpensive it is hoped that CLS will implement these recommendations. By implementing these recommendations it is more likely the training course will be beneficial to both CLS and the end users. If other evaluation techniques had been recommended that might have been more effective, yet more expensive, it is very likely CLS would reject the ideas. The end result would be the course would have no hope of adapting to the changing conditions at CLS and the overall exercise would have been futile.

7.3 Chapter Summary

The following sections will review the information presented in this chapter and will address areas where the recommendations from the literature were not met.

7.3.1 Review

The use of techniques beyond reaction sheets has been shown to be a more effective manner of gathering evaluative data. By performing a complete evaluation of the effectiveness of a training course, an organization is able to determine whether the training course has met the needs of the learners and the organization itself. Using these additional evaluative techniques can allow an organization to better address problems in the training course and issues in the workplace.

An organization must realize the additional costs involved with a more detailed level of evaluation. Evaluation of training should also be a process that is built
into the design of a training course. This was not performed during this project as it was beyond the scope of project proposal, although the information was included as it was thought that CLS would find it useful to use as a guide for developing an evaluation program. Organizations conducting evaluation should also realize there are situations where evaluation of a program may not be beneficial. The CLS section included recommendations on evaluative techniques that would be relatively easy for CLS to implement as part of their training program.

The discussion of evaluative techniques in this chapter will allow CLS to better determine what level of assessment is important to their organization. The recommendations for implementation of other levels of evaluation may act as a guide should CLS wish to assess the output of the training course beyond the reaction sheets that are currently in use.

7.3.2 Conclusions

The exclusion of an extended evaluative structure does not reduce the effectiveness of the training course that has been designed for CLS. However, CLS should consider assessing what further evaluative techniques, if any, they will use prior to taking the training course further within their organization. As the organization is still early in the stages of using the training course evaluative techniques can be chosen that should accurately reflect the affect the training course is having on the organization.
While it was not mandated by the training proposal it was felt that a discussion of the extra evaluative techniques would be important to assist CLS in selecting possible methods to further evaluate the training course. During the discussion of other evaluative techniques it was found that they should have been considered earlier in the training course development. This was a weakness of the project before it even began and was a direct result of inexperience in designing training courses.

While additional evaluative techniques were not considered earlier in the course development, these techniques can be and should still be employed. The positive outcome is that the use of a pilot group and the decision to further explore alternative evaluative techniques, revealed the lack of consideration given to these techniques. While these techniques should be developed as the training course is designed, there is time for CLS to implement an extended evaluation process if that is information that they would find valuable.
Chapter Eight - Conclusions and Recommendations

This final chapter will provide an overview of the training course design project. This will be followed by conclusions based on the course development at CLS. Finally, recommendations to improve the process of course design will be outlined.

8.1 Project Overview

As discussed in chapter one the purpose of the project was the analysis of ergonomic issues for microscope users at Calgary Laboratory Services and the process of developing an ergonomic training course for those users. It was also addressed that the general public may be the end users of this training course. In the first chapter the seven elements used in the development of an ergonomic training course were determined through a literature review process. In the next six chapters the individual elements of training course design were further detailed, followed by an explanation of how each particular element in the design of a training course was applied at CLS. Six chapters were only used as elements six and seven were combined into a single chapter to make it easier for readers to see the link between evaluating and modifying the training course.

Chapter two determined possible strategies on how to determine whether or not training would be an appropriate control for CLS. Chapter two also outlined why a formal strategy was not used at CLS when a training course was proposed as an ergonomic intervention. In chapter three the importance of understanding the
needs of an organization was shown. It was argued that if the needs assessment had not been performed a true understanding of the requirements of management and staff could not have been developed. This may have resulted in unsuitable goals and objectives being selected. In chapter four the selection of specific objectives for the training course was stressed and the importance of having participation from all levels of staff and management was demonstrated. In chapter five, learning activities were selected based on the objectives and goals selected in the previous chapter. It was also demonstrated that the techniques used to provide the training could have an impact on the effectiveness of the training course. Chapters six and seven outline the piloting of the training course, the evaluation and modification of that pilot course and the evaluation of the training course as it is implemented across an organization.

Throughout the development of the training course there were difficult decisions that needed to be made. Some of these decisions included acting as a surrogate when developing the course objectives, the choice of training modalities and the choice of evaluation methods.

In each instance when these decisions were made the justification for the decision was also explained. In each instance where there was a difference between the suggested theory and the actual actions, there was an assessment of the impact on the training course. It was also recognized that in future efforts to design training courses these types of decisions should be avoided when
possible. Although it should be noted it might be impossible in this type of project to entirely avoid this type of decision-making process.

When all of these "finesse" decisions have been made it becomes important to determine whether they have impacted the objectives of the project. In this case I would argue that there are two objectives that need to be considered. The first is the objective of the MDP and the second is the mission statement of the training course.

The objective of the MDP was to address the analysis of ergonomic issues for microscope users at Calgary Laboratory Services and the process of developing an ergonomic training course for those users. I would argue that one of the most interesting elements of this process has been the application of theory to a real-world situation and discovering the inherent difficulties in doing so. Many of these difficulties were the result of these finesse real-world decisions that needed to be made when the theory did not provide a clear direction. Many of the difficulties were also discovered when events in the real world forced a compromise with the researched theory. In the end I would argue that these finesse decisions are one of the greatest challenges that face training course designers or any academic when applying theory as action items. Often theory is not developed highly enough to handle issues that can take place in the real world. In these situations finesse decisions came as result of the selecting the MDP purpose of applying theory in a real-world situation.
The major question becomes whether the finesse decisions affected the development of the training course by inhibiting the achievement of the mission statement. At this stage in the course development process it is difficult to determine. In each instance the rationale for not applying theory was given and it assessed how the decision could impact the course and what action was taken to mitigate these impacts. However a true determination of the ability of the training course to achieve the mission statement cannot be determined until further evaluation is performed when the course is presented to more participants. This evaluation may be the types recommended in chapter seven.

In each instance when finesse decisions were undertaken there was an effect on the training course. When considering the cumulative effect of these decisions the course designer must feel comfortable that they have not negatively impacted the value of the final product before they present the course. The end result of these decisions can only be verified by evaluations of the course effectiveness. This cumulative impact of the finesse decisions will be further discussed in the next section.

8.2 Calgary Laboratory Services

The process of applying the literature review to the real world situation of course design at CLS and the conclusions drawn from that application, will now be discussed.
8.2.1 CLS Conclusions

The scope of the training course design project was to integrate both the theoretical and practical elements of training course design up to the point of reactive evaluation. By using a literature review process seven elements of training course design were selected as the key steps to employ when developing a training course. By using these seven theoretical elements of training course design and applying them to a real world situation, some of the difficulties training course designers encounter were discovered. In this project these difficulties included; using a formal strategy to select a control, lack of a management staff supervisory committee and ensuring that evaluation is a key element of training course design. Issues were also raised as a result of the framework that was selected, the decision to only use a training control and problems concerning the social context under which the course was developed. All of these issues are related and have an effect on one another.

These difficulties resulted from a variety of reasons, including the resources made available by CLS, a lack of management-staff cooperation, the social context at CLS and the scope of the project being restricted in order to have a manageable MDP project. It was shown in each instance what effects these issues may have had on the training course. In each situation decisions were made in attempt to mitigate the possible negative outcome resulting from these decisions.
It addition to determining whether each finesse decision had an individual effect on the course it should be considered whether these decisions had a cumulative effect on the training course. There are a huge number of finesse decisions that are made in the design of a course. The framework the course will use the learning modalities selected, the psychological training model selected, how communication issues were resolved, evaluation techniques that were recommended, the use of only a training control, and the types of analysis used with data to name a few.

The final decision must be that the effect of these decisions must be significant although not necessarily measurable. By this I mean that if each decision had a very small impact on the course the overall effect may be quite large although proving this could be difficult. This is because of the nature of the environment where a training course is implemented and because the decisions made may not have an impact that is expected. The combination of a real-world environment and unintended consequences makes the effect nearly impossible to measure.

In the end the intention of the course designer is that an effective tool for addressing ergonomic hazards in the workplace has been developed. To date theory is not developed to the point where it can provide direction to a course designer in all situations. As a result a course designer must make finesse decisions when developing a course. What is important is that a course designer
makes finesse decisions in a consistent manner during the development process. By doing so the designer will be better able to understand the problems that arise during the development of the course. As a result the designer may be able to make changes to mitigate these problems.

As was mentioned there were many finesse decisions made during the development of the course at CLS. These decisions were made from a framework that included research on training theory. The decisions were also made as a result of research and information on instructional models, the social context at CLS and systems frameworks. By applying this information and research consistently throughout the project it is hoped that the outcome of the training course will be positive. It was demonstrated however that there are issues that CLS will need to address to ensure that the training course is successful.

Prior to outlining recommendations for improving the process of training course design a brief discussion of the impact of the training course needs to be held. As was discussed on page five in the purpose and scope section, the end users of the training course might be considered the public for whom the tests are being performed. Certainly if the implementation of the training course has an impact on the efficiency or throughput of the testing process or the increase or decrease in false results; then the public for whom the tests are performed may be considered one of the end users of the training course.
One of anticipated outcomes of this MDP was that the microscope users at CLS would feel a positive impact through improved well-being and health in the workplace. Through this positive outcome it was also hoped that CLS experiences positive impacts through reduced medical costs and increased employee efficiency.

Many consider the fundamental function of ergonomics is to ensure human needs for safe and efficient work, are designed into work systems. The term safe refers to the ability of the worker to operate in a physical and psychological comfort zone that is suitable to the task being performed. When a worker experiences excessive mental or physical workloads it is often the case that system performance and reliability are reduced.

This MDP project was not developed to the point where microscope user error was measured, although it did propose to reduce ergonomic risks in the work environment through the use of a training course. It can be argued as a result of assessing ergonomic risk factors at CLS and giving microscope users the skills to mitigate those hazards, the microscope users benefited from a safer work environment. As a result of this improved or safer environment the general public may also benefit from reduced errors or false results in the testing process. In any case it would be unlikely that as a result of trying to provide the microscope user a safer work environment that there would be an increase of
false results or that the general public would experience any negative impact as
the result of the development of this training course. Additionally, if as a result of
mitigating ergonomic risk factors, throughput is increased without additional
reports of errors then the general public is also served better by being able to
receive the results of what may be crucial medical tests in a more timely fashion.

8.3 Recommendations

In this section recommendations to improve the training course development
process will be given. These recommendations can be applied to the process of
training course design outlined in this document. Organizations can use these
recommendations to improve the development process of ergonomic training
courses. In addition, these recommendations may also apply to other types of
training. The three recommendations will now be detailed.

8.3.1 Use all Stages of Training Course Design

As a result of going through the process of training course design with CLS the
importance of using all elements of the process correctly was made clear. In
each instance where there was variation between the design of the CLS course
and the literature, it needed to be determined whether the disparity significantly
impacted the development of the course. In this MDP it was argued that the
differences between the literature and the development of the CLS course did not
negatively impact the final product. However, if differences between the
literature and what was actually performed negatively impacted the course, that
phase of the project would have needed to be performed again or the
effectiveness of the course may be compromised. Differences resulting in negative impacts on a course may waste valuable resources.

It should be expected that real world situations might prevent a training course designer from perfectly applying theoretical elements of training course design in all situations. This may force the designer to make finesse decisions. Having a firm understanding of course design allows the designer to make decisions in a consistent manner as to least affect the development of an effective product.

8.3.2 Building Evaluation into the Process

While some elements of evaluation were beyond the scope of this project, it was felt this stage of a course development should be stressed as one of the most important elements in the design process. Using evaluative techniques ensures the effectiveness of a training course by using a process of constant improvement. It does this by allowing the course designer to determine how effective the course has been at reducing hazards. This evaluation can lead to refinement of the course as mentioned or may lead to using other more effective controls to reduce workplace hazards. Regardless of how the evaluation process is used, it is the only manner organizations can measure how effectively resources are being used. As a result evaluation should always be included as part of the course design process.
8.3.3 Gaining Support from Key Players

In chapter two the importance of gaining support from key players in an organization was stressed. Without the involvement of key players there may not be the support necessary to complete the project, as each person can assist in the development of the course in their own way. This process of gaining support for a program is not one that is mentioned in the literature on training course design. The literature in this area focuses on the mechanical process of training course design and not the strategic implications that need to be considered when using this type of intervention. Perhaps the most important recommendation, the training course designer should always consider how to position the development of a course to give it the greatest chance of succeeding within an organization.

8.4 Chapter Summary

The end product of this MDP is a training course that has been used at CLS to attempt to improve employee skills and awareness relating to ergonomic issues within the workplace. The document that may assist other training course designers when developing ergonomic training by showing the steps that can be used to develop a course, the difficulties that may be encountered while developing a course and recommendations to improve the process.
Chapter Nine - References


137 Ballantyne, R., Borthwich, J. & Packer, J. (Series Editors) Enhancing Teaching and Learning; Evaluating the Quality of Teaching. Issue No. 6, Brisbane, Queensland, Queensland University of Technology.


This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take the time to read this form carefully and to understand any accompanying information.

The purpose of this project is to design an adjustable microscope stand for Calgary Laboratory Services. Your participation in the Task Analysis will involve being observed in your typical work practice while using a microscope, answering questions relating to your experience using a microscope, and being videotaped or having still photographs taken of you while working at the microscope.

Disruption and inconvenience to your work will be kept to a minimum. Calgary Laboratory Services supports your participation in this project if you wish to volunteer.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions concerning matters related to this research, please contact Trish Willis, 210-7585. If you have any questions concerning your participation in this project you may also contact Ron Wardell, Associate Professor Faculty of Environmental Design, 220-2717.

I agree to participate in this project by participating in a Task Analysis. I agree to video and/or still photographs of me being used by the project team for the purpose of designing a microscope stand.

Participant

Date

I consent to the use of video and/or still photographs of me being used in presentations of this project.

Participant

Date

A copy of this consent form has been given to you to keep for your records and reference.
Appendix 2

Sample Checklist for Task Analysis at Calgary Laboratory Services
(Adapted from A Guide to the Ergonomics of Manufacturing)

Workplace Characteristics

___ Extended lateral or forward reaches, at or beyond normal reach
___ Inaccessible/inadequate workspace for equipment and materials
___ Chairs are difficult to adjust while seated
___ Chairs have inadequate back support or incorrectly placed
___ Lack of or inadequate foot rests
___ Doesn't use foot rest
___ Workplace layout leads to inefficient motions:
   - Twisting to write, etc.
   - Reaching around scope
   Other:
___ Awkward postures are required
___ Lack of built-in adjustability in workspace
___ Work surface too high or low
___ Workers frequently adjust chairs by adding cushions/padding
___ Workers adapt worksurface:
   - Add arm padding
   - Raise scope with various items
   Other:
___ Arms are held in static positions to maneuver scope controls
   - With arm supports? Y / N
   - Inadequate arm supports? Y / N
___ Minimal room to move about
___ Insufficient kick space
Inadequate space for legs
Inadequate work surface space
Seat surface not padded
Inadequate back support

**Specific Equipment**

- Pinch points are not adequately guarded
- Scope controls are at uncomfortable locations, require static loading in unsupported positions
- Scope height in not adjustable

**Physical Demands**

- Constant handling of material with very little variety
- Task requires handling of difficult to grasp objects
- Static muscle loading
- Thin edges exert high pressure on the hands
- Workers complain of fatigue and discomfort

- Neck
- Shoulders
- Back
- Arms
- Legs

**Work Methods**

- Motion range requirements are anatomically unacceptable
- High precision motion requirements for extended time
- One motion pattern is repeated at high frequency
- Hand controls are used in incorrect hand positions
- Requires twisting motions
Motion patterns frequently require work w/ elevated hands/arms
Elbows are not close to body (forward flexion)
Appendix 3

Project Title: The Design of an Ergonomic Training Course for Calgary Laboratory Services

Researcher: Tom Coffyne  Phone: 615-8555  Email: tjcoffyn@ucalgary.ca

The purpose of this questionnaire is to collect information about microscope use and ergonomic knowledge at Calgary Laboratory Services. This is part of a joint project between the Faculty of Environmental Design and Calgary Laboratory Services. Your completion of this questionnaire is voluntary, however, your accurate responses will provide important information into the proposed design of an ergonomic training course for microscope users. All responses are confidential, your identity will be protected, and only composite information gathered from the questionnaires will be provided to CLS. If you have any questions concerning the ethics review of this project, or the way you have been treated, you may also contact the office of the Vice-President (Research) and ask for Karen Mcdermid, 220-3381. If you have any questions concerning the project please contact the researcher, Tom Coffyne. Your decision to complete and return this questionnaire will be interpreted as an indication of your consent to participate.

Section 1: Please check the appropriate response.

1. Gender: Male  Female

2. Handedness: Right  Left

3. Age: < 30 yrs old  30-40 yrs old  40-50 yrs old  > 50 yrs old

4. Position: Laboratory Assistant  Technologist  Resident  Pathologist

5. Work Area: Cytopathology  Microbiology  Urinalysis  Hematology  Anatomical Pathology  Other

6. How long have you worked in this type of position? < 1yr  1-5 yrs  6-10 yrs  11-15 yrs  > 15 yrs

7. How many hours do you spend working on a microscope during a single shift? < 2 hours  2 - 4 hours  5 - 7 hours  > 7 hours

8. How many hours in one week do you typically work at microscope? < 10 hours  10 - 20 hours  21 - 30 hours  31 - 40 hours  > 40 hours

9. Do you have your own microscope workstation? Yes  No

If NO, how often do you share or change workstations? Hourly  Daily  Weekly
Section 2: Please check the appropriate response.

10 Have you experienced discomfort, numbness or pain in any part of your body during the day or when you go home at night, since you began your present job?

- No: discomfort or pain (please proceed to question 19)
- Yes: please record your pain and/or discomfort according to the instructions below.

Please put a check (✓) according to how often you feel pain or discomfort that you would relate to your job functions in the following body parts.

<table>
<thead>
<tr>
<th>BODY PART</th>
<th>FREQUENCY OF PAIN OR DISCOMFORT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NEVER (ABSOLUTELY NO INCIDENTS)</td>
</tr>
<tr>
<td>Head/Eyes</td>
<td></td>
</tr>
<tr>
<td>Neck</td>
<td></td>
</tr>
<tr>
<td>Shoulders</td>
<td></td>
</tr>
<tr>
<td>Arms/Hands/Wrists</td>
<td></td>
</tr>
<tr>
<td>Back/Torso</td>
<td></td>
</tr>
<tr>
<td>Legs/Feet</td>
<td></td>
</tr>
</tbody>
</table>

Please characterize your discomfort/pain:

If you experience pain or discomfort within any body part, write the number corresponding with the scale in that body part.

**Rating Scale**

1. No discomfort
2. Light discomfort
3.
4. Moderate
5.
6. More than moderate
7.
8. Very uncomfortable
9.
10. Painful
11. What time does the discomfort occur regularly? (Tick all boxes that apply.)
   Mornings    Afternoons    Evenings    Night

12. Do these symptoms continue for more than 1 hour after you have stopped working at the microscope workstation?    Yes    No

13. Does the discomfort prevent you from working in an efficient manner?    Yes    No

14. Has the discomfort caused you to awake while sleeping?    Yes    No

15. Does the discomfort interfere with your daily activities (eating, writing, sports etc.)?    Yes    No

16. Have you reported these symptoms to your supervisor or the safety and environmental coordinator?    Yes    No

17. Have these symptoms been reported to the WCB?    Yes    No

18. Have you received medical treatment for these symptoms?    Yes    No

   If yes, what type of treatment have you received (i.e. surgery, physiotherapy, stretching exercises or medication)?

Section 3: Please circle the appropriate response.

19. Do you understand the known and suspected health effects and symptoms associated with the use of a microscope workstation environment, including:

   Musculoskeletal Fatigue    Yes    No
   Musculoskeletal Discomfort    Yes    No
   Cumulative Trauma Disorders and early symptoms    Yes    No
   Visual Fatigue and Discomfort    Yes    No

20. Do you understand the known and suspected causes of office related health effects, including:

   Improper Workstation Design    Yes    No
   Awkward Postures    Yes    No
   Static Postures    Yes    No
   Inappropriate Lighting    Yes    No
Improper or No Visual Correction

21. Do you understand the ergonomic principles that can be applied to abate ergonomic hazards, including:

<table>
<thead>
<tr>
<th>Ergonomic Principle</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workstation &quot;Fit&quot;</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Appropriate Use of Workstation Accessories</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Importance of Workstation Adjustability</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Proper Body Posture from Head to Toe</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Proper Work Practices</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rest Breaks</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Reduction of Glare</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Screen Contrast/Brightness Adjustment</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Thank you for your time and effort in completing this questionnaire. This information is very important for the successful completion of this project. Please place your completed form in the boxes that have been provided by Friday April 7th. If you have any questions about this survey or the project as a whole, please contact Tom Coffyne at 615 - 8555
Appendix 4

Interview Consent Form - University of Calgary
Faculty of Environmental Design

Project Title:
The Design of an Ergonomic Training Course
For Calgary Laboratory Services

Investigator: Tom Coffyne
Supporting Agency: Calgary Laboratory Services

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take the time to read the attached form carefully and to understand the accompanying information.

Your signature on this form indicates that you have understood, to your satisfaction, the information regarding the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions related to this research, please contact:

Tom Coffyne
Phone - (403) 615 - 8555
Email - tjcoffyn@ucalgary.ca

2500 University Drive NW
Calgary, Alberta
T2N - 1N4

If you have any questions concerning the ethics review of this project, or the way you have been treated, you may also contact the office of the Vice-President of (Research) and ask for Karen McDermid (403) 220 - 3381. If you have any concerns about the project itself, please contact the researcher.

Participant ____________________________________________________________________________
Date __________

Researcher (Optional) ____________________________________________________________________
Date __________

A copy of this consent form has been given to you to keep for your records and reference.
Consent Form Information For Interviews

Purpose:
The purpose of this project is to develop an ergonomic training course that will give microscope users at Calgary Laboratory Services (CLS) the tools needed to reduce strain and discomfort experienced in the workplace.

Methods:
The training course is to be developed through a literature review and through the participation of the management and microscope users at CLS.

The literature review will collect information from two distinct fields of study.

1. Literature will be collected outlining the types of ergonomic issues facing microscope users. The purpose will be to develop an understanding of the ergonomic issues facing microscope users and to gather information on how these ergonomic risk factors can be mitigated.
2. Literature will also be collected outlining the elements that should be considered when developing a staff-training course. The purpose will be to ensure that the finished course disseminates the material in the best possible manner.

Participation of the management and workers of CLS will also be used to develop the training course. This will ensure that the finished product is a training course that is best suited to the workers at CLS. This participation will be instigated in two ways.

1. Management will have the opportunity to be interviewed. The purpose of these interviews will be to ensure that the training course is developed and instructed in a manner that is acceptable to CLS.
2. Microscope users will be asked to complete a voluntary questionnaire. The purpose of this questionnaire will be to determine the current ergonomic knowledge at CLS and to determine the types of ergonomic issue faced by the workers.

The finished training course will then be given to a group of CLS management and workers. These participants will evaluate the training course, with appropriate changes being incorporated into the final product.

Expectation of Research Subject:
The interviews will be conducted with the management at CLS that have an interest in the project and volunteer to talk with the researcher. The interviews are expected to last approximately 1/2 hour. Information that is being gathered relates to the ergonomic issues in the workplace, the current level of ergonomic knowledge among the staff and types of training that are acceptable in the CLS workplace. THE INFORMATION GATHERED IN THESE INTERVIEWS MAY NOT BE CONFIDENTIAL AS THE INTERVIEWEE MAY BE QUOTED IN THE FINAL MASTERS DEGREE PROJECT DOCUMENT. Although all information gathered will ONLY relate to the normal activities and expectations of the interviewees job.

Responsibilities of the Researcher:
The researcher will abide by the standards of ethical research as outlined by the University of Calgary. (A copy of which can be obtained from the researcher upon request) The researcher will hold all information collected as confidential except where otherwise noted. All information gathered during the course of this project will be stored in a secure location at the University of Calgary Campus. Upon the successful completion of the project all data gathered to accomplish the project will be destroyed. Updates on the current status of this project can be obtained by contacting the researcher, Tom Coffyne at 615 - 8555 or tjcoffyn@ucalgary.ca.
This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take the time to read this form carefully and to understand any accompanying information.

The purpose of this project is to design an ergonomic training course for Calgary Laboratory Services. Your participation in the course design will involve being observed in your typical work practice while using your workstation, answering questions relating to your experience using a microscope, and having still photographs taken of you while working at the microscope, which will be used as part of the training course.

Disruption and inconvenience to your work will be kept to a minimum. Calgary Laboratory Services supports your participation in this project if you wish to volunteer.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions concerning matters related to this research, please contact Tom Coffyne, 615-8555. If you have any questions concerning your participation in this project you may also contact Ron Wardell, Associate Professor Faculty of Environmental Design, 220-2717.

I agree to participate in this project by participating in the course material development. I agree to still photographs of me being for the purpose of designing a training course.

Participant_____________________________________

Date________________________

I consent to the use of still photographs of me being used in presentations of this project.

Participant_____________________________________

Date________________________

A copy of this consent form has been given to you to keep for your records and reference.
Introduction

The purpose of this manual is to provide Calgary Laboratory Services employees with ergonomic reference material to take with them following the completion of the ergonomic training course; Ergonomics for Microscopists.

This manual is not a stand-alone document and should only be used as reference material by those staff members that have completed the Ergonomics for Microscopists training course.

Objectives

Upon completion of the ergonomics-training course and through the use of this manual the participant should be able to:

- Understand how ergonomic risk factors can impact your well being in the workplace.
- Be able to assess your own work environment for potential ergonomic risks.
- Appreciate the value and importance of making simple changes to your work area in order reduce the ergonomic risk at your workstation.
- Understand how ergonomic problems can be dealt with at CLS.

Using This Manual

This manual contains the entire contents of the microscope ergonomics-training course. Throughout the presentation you are encouraged to take notes and ask questions to clarify any points you wish to discuss in further detail.

The manual also contains information on workstation adjustment, chair adjustment, exercises to reduce discomfort, a list of ergonomic resources that are available on the World Wide Web and information on handling your ergonomic concerns at Calgary Laboratory Services.

Upon completion of this course you are encouraged to immediately apply the knowledge you have acquired to reduce the ergonomic risks you are exposed to in your work area.
# Ergonomics for Microscope Users

## Objectives

1. Understand how ergonomic risk factors can impact your well being in the workplace
2. Be able to assess your own work environment for potential ergonomic risks
3. Appreciate the value and importance of making simple changes to your work area in order reduce the ergonomic risks at your workstation
4. Understand how ergonomic problems can be dealt with at CLS

## Agenda

- Review of Terms and Concepts
- Develop an understanding and ability to control general ergonomic risk factors
- Understand ergonomic hazards of microscope use
- Workstation adjustment at CLS
- Understand health and comfort strategies
- Available resources

## Terms and Concepts

- **Human Anatomy**
  - Muscles
  - Tendons
  - Ligaments
- **Definitions**
  - Ergonomics
  - Work Related Musculoskeletal Disorders
  - Cumulative Trauma Disorders
Ergonomics for Microscope Users

Terms and Concepts

- Anatomy
  - Human Musculoskeletal System
  - Provides an internal framework
  - With the action of muscles, ligaments and tendons provides mobility and stability about joints

Terms and Concepts

- Ergonomics
  - the study of human beings in relation to the design of objects, systems and environments for human use
  - Ergo + Nomos
    - "the natural laws of work"

Terms and Concepts

- From a Health and Safety perspective
  - Ergonomics is the science that addresses human performance and well-being in relation to the job, equipment, tools and the environment

Terms and Concepts

- Why the need for ergonomics?
  - Increasing Productivity Demands
  - Increasing Overtime Requirements
  - Increasing Quality Demands
  - Attracting and Retaining Quality Employees
  - Changing Workforce
  - Increasing Costs associated with injury
  - Regulations and Legislation
Ergonomics for Microscope Users

Terms and Concepts

• Work Related Musculoskeletal Disorders
  - These disorders also known as WMSDs are injuries and disorders of the muscles, nerves, ligaments, joints, cartilage and spinal discs

Terms and Concepts

• Cumulative vs. Acute Injuries
  - Acute Injuries
    • Accident, immediate event
    • High forces
  - Cumulative Injuries
    • Repetition
    • Over a period of time
    • Lower Forces

Terms and Concepts

• Common WMSDs
  - Ligament sprain
  - Muscle injuries
  - Tendonitis
  - Epiconylitis
  - Bursitis
  - Nerve Injuries
  - Vibration Syndrome

  All of these disorders can have a long term impact on employees work and personal lives

Terms and Concepts

• Cumulative Trauma Disorders (CTDs)
  - A term used for a variety of health disorders resulting from repeated stresses on the musculoskeletal system
  - E.g., Carpal Tunnel

Calgary Laboratory Services
Ergonomics for Microscope Users

Terms and Concepts

Possible Signs and Symptoms of a CTD
- Include:
  - Dull ache;
  - Tenderness;
  - Tingling or numbness; or
  - Restricted range of movement.

Mechanism
- The multifactorial nature of WMSDs is now well recognised. However, the proportion of attention given to individual, psychosocial and physical factors that might influence the onset or the prevention of these disorders is still unclear.


Terms and Concepts

Biomechanical Model

Terms and Concepts Summary
- Anatomy
  - Musculoskeletal system
- Ergonomics
  - Definition
  - Importance
- WMSDs
  - Signs and symptoms
  - Cumulative trauma disorders (CTDs)

Calgary Laboratory Services
## Ergonomics for Microscope Users

### General Ergonomic Risk Factors

- **Risk Factors**
  - Visual factors
  - Awkward postures
  - Musculoskeletal load
  - Repetition or invariability
  - Cold, vibrations and external trauma
  - Cognitive demands
  - Organizational factors
  - Psychosocial factors.

### Visual Ergonomics

- **Signs of Visual Fatigue**
  - General tiredness
  - Dry, itching feeling
  - Irritated eyes
  - Blurred Vision
  - Headaches

### Visual Ergonomics

- **Visual Risk Factors**
  - Glare
  - Workstation Layout
  - Uncorrected visual disorders
  - Prolonged, uninterrupted viewing
  - Display quality

---

Calgary Laboratory Services
Ergonomics for Microscope Users

**Visual Ergonomics**

- **Visual Risk Factors**
  - Indirect Glare

---

**Visual Ergonomics**

- **Visual Risk Factors**
  - Workstation Layout

---

**Visual Ergonomics**

- **Visual Risk Factors**
  - Uncorrected visual disorders
    - Astigmatism
    - Nearsightedness, farsightedness
  - Prolonged viewing times
    - Staring through microscope lens
    - Staring at computer monitor
  - Display Quality
    - Adjustment of brightness and contrast controls
    - Adjustment of focal controls

---

**Visual Ergonomics**

- **Controlling Visual Risk Factors**
  - Adjust height, tilt and placement of monitor

---

Calgary Laboratory Services
Visual Ergonomics

- Controlling Visual Risk Factors
  - Install window treatments and reposition task lights

Visual Ergonomics

- Controlling Visual Risk Factors
  - Clean monitor/microscope regularly and use anti-glare screens

Visual Ergonomics

- Controlling Visual Risk Factors
  - Position monitor and documents correctly

Visual Ergonomics

- Visual Summary
  - Controlling Risk Factors
    - Workstation Arrangement
    - Adjust Window Covering
    - Position or Adjust Task Lights
    - Adjust Monitor Tilt
    - Avoid Reflective Surfaces
    - Use a Hood or Glare Screen
Ergonomics for Microscope Users

Visual Ergonomics

- Visual Summary
  - Visual Setup
    - Place Top of Screen Just Below Eye Level
    - Use a Document Holder
    - Place Document and Monitor at Comfortable Viewing Distances
    - Consider Your Dominant Eye

Visual Ergonomics

- Visual Summary
  - Health and Comfort Strategies
    - Have Regular Eye Exams
    - Yawning / Blinking
    - Palming
    - Focus Change
    - Massage
      - Eye
      - Head (back, forehead, and side)

Visual Ergonomics

- Evaluation of Risk Factors

General Ergonomics

- Shoulder and Neck Concerns
  - Arm pain
  - Tension in shoulders or neck
  - Tendonitis
  - Shoulder or neck discomfort
Ergonomics for Microscope Users

General Ergonomics

• Shoulder and Neck Risk Factors
  – Poor Posture (e.g. bent neck)
  – Inappropriately adjusted equipment (e.g. monitor set to low)
  – Workstation Layout (e.g. reaching postures)
  – Stress and Muscular tension
Ergonomics for Microscope Users

General Ergonomics

- Controlling Shoulder and Neck Risk Factors
  - Sitting Posture

General Ergonomics

- Controlling Shoulder and Neck Risk Factors
  - Inappropriately Adjusted Equipment

General Ergonomics

- Controlling Shoulder and Neck Risk Factors
  - Workstation Layout

General Ergonomics

- Controlling Shoulder and Neck Discomfort
  - Health and Comfort Strategies
    - Shoulder Rotations
    - Shoulder Elevations
# Ergonomics for Microscope Users

## General Ergonomics

- **Evaluation of Risk Factors**

## General Ergonomics

- **Evaluation of Risk Factors**

## General Ergonomics

- **Arm and Wrist Concerns**
  - Tendonitis
  - Bursitis
  - Carpal Tunnel Syndrome
  - Repetitive Strain Injuries

## General Ergonomics

- **Arm and Wrist Risk Factors**
  - Repetitive Motions
  - High Forces
  - Awkward Positions
  - Hard Edges

Calgary Laboratory Services
Ergonomics for Microscope Users

General Ergonomics

- Arm and Wrist Risk Factors
  - Repetitive Motions

General Ergonomics

- Arm and Wrist Risk Factors
  - High Forces

General Ergonomics

- Arm and Wrist Risk Factors
  - Awkward Postures

General Ergonomics

- Arm and Wrist Risk Factors
  - Hard Edges
## Ergonomics for Microscope Users

### General Ergonomics

- **Controlling Arm and Wrist Risk Factors**
  - Keyboard set up and use

### General Ergonomics

- **Controlling Arm and Wrist Risk Factors**
  - Alternate Equipment

### General Ergonomics

- **Controlling Arm and Wrist Risk Factors**
  - Health and Comfort Strategies
    - Fist Release
    - Hand Shake
    - Massage

### General Ergonomics

- **Evaluation of Risk Factors**
Ergonomics for Microscope Users

General Ergonomics

- Back and Leg Concerns
  - Muscle Spasms
  - Pinched Nerves
  - Back Aches
  - Leg Discomfort

General Ergonomics

- Back and Leg Risk Factors
  - Awkward/Twisted Postures
  - Inappropriately Adjusted Equipment
  - Workstation Layout
  - Excessive Reaches
  - Static Postures
  - Unsupported Feet
  - Stress and Muscular Tension

Calgary Laboratory Services
General Ergonomics

- Back and Leg Risk Factors
  - Inappropriately adjusted equipment or layout

General Ergonomics

- Back and Leg Risk Factors
  - Excessive Reaches

General Ergonomics

- Controlling Back and Leg Risk Factors
  - Proper Posture

General Ergonomics

- Controlling Back and Leg Risk Factors
  - Equipment adjustment
Ergonomics for Microscope Users

General Ergonomics

- Controlling Back and Leg Risk Factors
  - Proper foot and leg support

General Ergonomics

- Controlling Back and Leg Risk Factors
  - Health and Comfort Strategies
    - Movement
    - Cable Stretch
    - Knee Raises
    - Shoulder Shrug, Rotation and Stretch
    - Neck Stretch
    - Foot Rotation and Toe Points
    - Massage

General Ergonomics

- Evaluation of Risk Factors

Microscope Ergonomics

- Introductory photograph of a microscope

Calgary Laboratory Services
Ergonomics for Microscope Users

Microscope Ergonomics

- Why is it important to focus on good ergonomic practice when working with microscopes?
  - 70.5% of Washington Cytotechnologists report some form of neck, shoulder or back discomfort. (ASCT website)
  - 84% of of microscopists in the Stockholm county hospital experience job related musculoskeletal pain. (Rizzo, Rossignol and Gauvin, 1992)

- Why the need for good ergonomic practice?
  - Microscope work contains many of the risk factors that are present in other workplaces that can lead to discomfort or injury.
  - A survey and interviews with staff members shows that CLS has similar ergonomic problems as other labs reported on in the literature.
  - Failure to address ergonomic risk factors may lead to higher injury rates and reduced productivity.

Microscope Ergonomics

- What body parts are affected by pain or discomfort at CLS?
  1. Neck discomfort
  2. Head discomfort (eyestrain/headaches)
  3. Shoulder discomfort
  4. Arm/hand/wrist discomfort
  5. Back discomfort
  6. Leg/foot discomfort

- Microscope Risk Factors
  - Prolonged awkward neck and back postures while viewing samples
  - Unacceptable wrist postures to manipulate samples and adjusting microscope controls
  - Mechanical stress to the elbows, forearms and wrists while manipulating samples and adjusting microscope controls
  - Prolonged viewing leading to headaches and visual strain
  - Lack of lumbar support leading to neck shoulder and lumbar pain

Calgary Laboratory Services
<table>
<thead>
<tr>
<th>Microscope Ergonomics</th>
<th>04/09/2002 Calgary Laboratory Services 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolonged awkward neck and back postures</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Microscope Ergonomics</th>
<th>04/09/2002 Calgary Laboratory Services 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unacceptable wrist postures</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Microscope Ergonomics</th>
<th>04/09/2002 Calgary Laboratory Services 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical stress</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Microscope Ergonomics</th>
<th>04/09/2002 Calgary Laboratory Services 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor support leading to neck shoulder and back pain</td>
<td></td>
</tr>
</tbody>
</table>

Calgary Laboratory Services
### Microscope Ergonomics

- Controlling microscope risk factors
  - Microscope workstation design
    - Neck flexion no greater than 30 degrees
    - Upper arm vertical, forearms horizontal and supported on the work surface
    - Wrists held in neutral posture
    - Keep back supported in neutral position
  - Neck flexed no more than 30 degrees

### Microscope Ergonomics

- Controlling Microscope Risk Factors
  - Forearms supported on work surface

### Microscope Ergonomics

- Evaluation
  - Good
  - Bad

---

Calgary Laboratory Services
Ergonomics for Microscope Users

Microscope Ergonomics

- Evaluation
  - Good
  - Bad

Ergonomic Resources

- Resources on the web
  - www.ewiworks.com
  - www.openerg.com
  - www.ergo.human.cornell.edu/
  - www.me.berkeley.edu/erg/services/tips.html
  - www.ncerc.com
  - www.cdc.gov/niosh
  - www.alimed.com
  - www.cssinfo.com

Ergonomics at CLS

1. Self analysis or analysis with person who has received ergonomic training
2. Approach supervisor discuss additional changes that can be made
3. Together with supervisor request assistance from environmental health and safety group
4. If problem continues make a formal accident/incident report and seek medical assistance

The End

Questions?
Recommended Work Area Set Up

- Adjust the backrest to provide support for the lower back.
- Alternate working position between standing and sitting if possible.
- Bring the mouse and telephone closer to reduce the amount of reaching required.
- Clean the monitor screen on a regular basis.
- Ensure blinds are closed during peak sunlight times of the day to reduce reflected window glare.
- Incorporate task variety and micro breaks throughout the workday.
- Keep the area under the work surface clear of clutter to provide enough legroom when sitting.
- When writing on documents, position documents on the side with the dominant hand or swivel the chair to face documents directly.
- Maintain a straight wrist posture while resting between keying functions.
- Rest the wrists on the wrist support between keying functions only.
- Remember to perform exercises throughout the day to reduce tension and levels of discomfort.
- Adjust the height of the chair to achieve a straight wrist posture with the keyboard at elbow height.
- Keep feet supported on the floor.
- When working on the computer for long periods of time, remember to blink periodically.
Workstation Adjustment

Beginning in box 1 use this flowchart to set up your workstation in the correct order.

1 - Can you raise and lower both your monitor and keyboard.
   If No go to 2
   If Yes go to 1A

1A - Adjust Feet First
   Adjust chair height to place feet flat on the floor.
   With feet flat on the floor, thighs should be parallel to the floor.

1B - Hang arms at side; bend elbow until forearms are parallel to the floor; Adjust armrest to gently support forearm or remove if unable to adjust properly

1C - Adjust keyboard height until a straight line exists from the elbow through the wrist to the knuckles

1D - Adjust the monitor height to just below eye level

2 - Can you raise and lower your keyboard but not your monitor.
   If No go to 3
   If Yes go to 2A

2A - Adjust Head First
   Place monitor at lowest possible height; Adjust chair until monitor is just below eye level
   - If chair is too high use a footrest and go to 2B
   - If chair is too low, go to 3A

2B - Adjust footrest height to place feet flat with thighs parallel to the floor

2C - Hang arms at side; bend elbow until forearms are parallel to the floor; Adjust armrest to gently support forearm or remove if unable to adjust properly

3 - If you can not raise and lower your keyboard.
   Go to 3A

3A - Adjust Hands First
   Hang arms at side; bend elbow until forearms are parallel to the floor; Adjust armrest to gently support forearm or remove if unable to adjust properly

3B - Adjust chair height until a straight line exists from the elbow through the wrist to the knuckles placed on the keyboard
   - If chair is too high use a footrest and go to 3C
   - If chair is too low, equipment changes may be required, contact supervisor

3C - Adjust footrest height to place feet flat with thighs parallel to the floor

3D - Position monitor just below eye level; If monitor can not be lowered equipment changes may be needed; contact supervisor

Workstation Adjustment Complete - Position accessories such as telephone, document holder according to frequency and sequence of use.
Chair Adjustment

There are a great variety of chairs that are available in most work environments. Correctly using the adjustments that a chair has available is vital in reducing the ergonomic hazards that are present in the work place. It is important to take time to determine the adjustments that your chair is capable of performing and use them correctly. The following points describe the manner in which most adjustments are made.

**Typical Task Chair Features**

1. Seat height adjustment – Allows the user to modify the height of the seat pan. The user should adjust the seat pan so that their thighs are approximately parallel to the floor with their feet flat on the floor or a footrest.

2. Seatback height adjustment – Allows the user to adjust the height of the seatback. The user should adjust the lumbar support to provide support to the lower curve in the back. (Typically just above the belt line)

3. Seatback angle adjustment – Allows the user to tilt the seatback forward and backwards. This should be adjusted so that the user is provided with back support whenever they are seated.

4. Seat pan tilt adjustment – Allows the user to adjust the seat pan forward and backward to angles that are not parallel to the floor. Can be used to provide a variety of postures throughout the workday but should not be adjusted so that excess stress is placed on the soft tissues in the legs.

5. Arm rest adjustment – Allows the user to adjust the height of the armrests. Should be adjusted so that the forearms can be maintained parallel to the floor without pushing the shoulders out of a relaxed posture.

6. Seat pan slider adjustment knob – Allows the user to adjust the depth of the seat pan in relation to the seat back. The user should adjust the seat pan so that the pan provides as much support as possible to the lower leg without making contact with the back of the knee.
OFFICE ERGONOMICS
Personal Exercises and Practices

**HANDS**

**Fist/Release**
- Make a fist with both hands; hold for three counts.
- Then, release fist so that the fingers are spread in a star-fish shape and hold for three counts.
- Repeat three times.

**Hand Shake**
- Drop arms and hands to your sides.
- Shake hands gently.

**EYES**

**For the Eyes**
- Ensure you blink. While looking at the monitor there is a tendency to blink less often, so consciously try to blink more regularly.
- Expose the eyes to natural light during the work day.
- Close your eyes and hold for 30 seconds—open your eyes slowly.
- Direct airflow from air conditioners or fans away from the eyes.

**FOCUS CHANGE**
- Focus on an object approximately six inches away, such as your coffee cup.
- Then focus on an object on the wall.
- Now focus on an object outside of your work area.
- Then look back to the object on the wall.
- Finally, focus on the object six inches away.

**BODY**

**Shoulder Shrug**
- Sitting up straight, slowly bring your shoulders up.
- Hold, then bring your shoulders down and hold.

**Shoulder Rotations**
- Slowly rotate both shoulders backwards for a count of 10, relaxing and breathing deeply as you do.
- Then slowly rotate both shoulders forward for a count of 10, again relaxing and breathing deeply.

**EXECUTIVE STRETCH**
- Place your hands behind your head and bring your elbows back.
- Gently stretch and lean back in your chair, arching your back slightly. Relax.
- Repeat three times.

**Foot Rotations**
- Slowly rotate foot in one direction for a count of three, and then in the other direction for a count of three. Relax. Repeat with other foot.

**ADDITIONAL REMINDERS**
- Eat a balanced diet.
- Perform personal exercises throughout the work day.
- Maintain a regular exercise routine.
- Ensure you get enough sleep on a regular basis.
- Reduce the level of stress in your life.
- Have your eyes examined regularly.
Online Ergonomic Resources

Consultant Web Sites
EWI Works - www.ewiworks.com
Open Ergonomics - www.openerg.com
Human Tech - www.humantech.com

Educational Web Sites
Cornell University - www.ergo.human.cornell.edu/
University of California, Berkeley - www.me.berkeley.edu/erg/services/tips.html
Northern Carolina Ergonomics Research Center - www.ncerc.com

Government Web Sites
NIOSH - www.cdc.gov/niosh
Government of Alberta - www.gov.ab.ca/hre/whs

Product Retailers Web Sites
Alimed - www.alimed.com
International Source for Ergonomics - www.visual-ergonomics.com

Standards Web Sites
Canadian Standards Association - www.cssinfo.com
American Standards Institute - www.ansi.org
Ergonomics at Calgary Laboratory Services

1. Perform a self-analysis or ask assistance from someone who has taken the ergonomic training course at CLS. Remember to assess your workstation; tasks that you perform, the time and manner in which tasks are performed as well as whether you are taking the time perform the provided health and comfort strategies.

2. If you are unable to resolve the discomfort or problem you are experiencing approach your supervisor to discuss additional changes that might be made to your workstation and tasks that you perform.

3. If after further modifications are made or there are difficulties in determining what further changes can be made contact the Environmental Health and Safety work group with the assistance of your supervisor. This group will be able to apply further expertise that goes beyond the materials presented in the Microscope Ergonomics Training Course.

4. If the discomfort or problem continues; together with a representative from the Environmental Health and Safety work group; make a formal accident/incident report and seek medical assistance.

Thank you for taking the time to take part in this training course. If there is material that you would like to see included in subsequent training courses or recommendations you have to improve this training course be sure to fill out the provided evaluation forms or approach the instructor directly.
Appendix 7

Ergonomics for Microscopists

Tom Coffyn

Faculty of Environmental Design
University of Calgary

Introduce yourself and how you have come be teaching this training course. Include qualifications, length of course (2.5 – 3 hours), and any personal preferences when teaching a course such as addressing questions throughout the course or only at the end of a section. Stress the importance of this course and the positive outcome that can come as a result of using the information.
Objectives

1. Understand how ergonomic risk factors can impact your well being in the workplace
2. Be able to assess your own work environment for potential ergonomic risks
3. Appreciate the value and importance of making simple changes to your work area in order reduce the ergonomic risks at your workstation
4. Understand how ergonomic problems can be dealt with at CLS

Present the objectives of the training course to the staff. Inform the staff that by attending the training course and using the manual they will be able to achieve each of these objectives. Introduce the Employee Ergonomic Resource Manual. Show them each major section in the manual. Inform them that the manual is theirs to keep and that notes can be made throughout the course to clarify information presented in each slide.
Present the outline of the training course. By moving through each section staff will be able to achieve the objective listed in the previous slide. Ask staff if there are any specific topics or areas they wish to discuss during the course. It is important to get a two way flow of information during the training course to ensure staff needs are met. Discuss how the course will move from general ergonomic risk factors, to body parts to applying the information specifically to the microscope work environment.
### Terms and Concepts

- **Human Anatomy**
  - Muscles
  - Tendons
  - Ligaments
- **Definitions**
  - Ergonomics
  - Work Related Musculoskeletal Disorders
  - Cumulative Trauma Disorders

Overview of the first section. Ask staff how comfortable they feel with this type of information as this section can be shortened if students have a firm grasp of the terms and concepts used in the course.
Terms and Concepts

- Anatomy
  - Human Musculoskeletal System
  - Provides an internal framework
  - With the action of muscles, ligaments and tendons provides mobility and stability about joints
Terms and Concepts

Ergonomics
the study of human beings in relation to
to the design of objects, systems and
environments for human use

Ergo + Nomos
"the natural laws of work"
Terms and Concepts

• From a Health and Safety perspective
  - Ergonomics is the science that addresses human performance and well-being in relation to the job, equipment, tools and the environment

![Diagram: Capabilities of people vs. Demands of the job]
## Terms and Concepts

- Why the need for ergonomics?
  - Increasing Productivity Demands
  - Increasing Overtime Requirements
  - Increasing Quality Demands
  - Attracting and Retaining Quality Employees
  - Changing Workforce
  - Increasing Costs associated with injury
  - Regulations and Legislation

---

Apply the need for ergonomics to the microscope work environment. For example increasing productivity demands by having to complete increased numbers of slides each shift or other pertinent examples.
Terms and Concepts

- Work Related Musculoskeletal Disorders
  - These disorders also known as WMSDs are injuries and disorders of the muscles, nerves, ligaments, joints, cartilage and spinal discs

WMSD's are multifactorial in nature and can be caused by a number of reasons but repetitive motions, low forces, awkward postures and static postures are the main culprits
Note the difference between the two types of injuries. Cumulative injuries are the primary injuries found in the microscope work environment. They are caused by the body not having enough time to recover between stresses hence the pail analogy.
Terms and Concepts

- Common WMSDs
  - Ligament sprain
  - Muscle injuries
  - Tendonitis
  - Epiconyliitis
  - Bursitis
  - Nerve Injuries
  - Vibration Syndrome

All of these disorders can have a long term impact on employees work and personal lives.

Ensure that students understand that all of these injuries are considered WMSD’s. Also stress the very significant long term health impacts these injuries may have such as the inability to function in given jobs or leisure activities. It is important that the staff understands these injuries can impact you permanently if not addressed properly.
Ensure staff understand that CTD's are a type WMSD caused by repeated stress on the musculoskeletal systems and that carpal tunnel is just the most common. The group of injuries are known as RSI's or CTD's. Link this back to the pail analogy used in a previous slide.
Terms and Concepts

- Possible Signs and Symptoms of a CTD
  - Include:
    - Dull ache;
    - Tenderness;
    - Tingling or numbness; or
    - Restricted range of movement.

Poll the staff on who has experienced some or all of these signs. Get a feeling of the types of issues that are raised so that they can be addressed in the appropriate section of the course. It is important to encourage action by the staff to address their needs. Inform them that by the end of the course you will have demonstrated an appropriate course of action to deal with these signs and encourage them to use it!
Terms and Concepts

- Mechanism
  - The multifactorial nature of WMSDs is now well recognised. However, the proportion of attention given to individual, psychosocial and physical factors that might influence the onset or the prevention of these disorders is still unclear


The physical realm is not the only item to consider. Those individuals that are more prone to stress typically experience higher rates of musculoskeletal discomfort in some body parts.
This is the model we will use. By controlling posture, force and repetition we will attempt to reduce CTD’s.
## Terms and Concepts

- **Terms and Concepts Summary**
  - Anatomy
    - Musculoskeletal system
  - Ergonomics
    - Definition
    - Importance
  - WMSDs
    - Signs and symptoms
    - Cumulative trauma disorders (CTDs)

Ensure that the staff are comfortable with the terms that will be used. Review any terms necessary and encourage staff to discuss any issues or concerns they may have.
General Ergonomic Risk Factors

- Risk Factors
  - Visual factors
  - Awkward postures
  - Musculoskeletal load
  - Repetition or invariability
  - Cold, vibrations and external trauma
  - Cognitive demands
  - Organisational factors
  - Psychosocial factors.

Introduce the general ergonomic risk factors and demonstrate the link between the biomechanical model and these risk factors. Introduce how we will discuss different body sections (visual, neck and shoulders, arms and wrists, back ad legs) and how these risk factors can impact each body part. Next section will be visual ergonomics.
Visual Ergonomics

- Signs of Visual Fatigue
  - General tiredness
  - Dry, itching feeling
  - Irritated eyes
  - Blurred Vision
  - Headaches

Poll staff on who has experienced these symptoms the frequency and severity. Use this as a gauge of how to address this section.
Visual Ergonomics

- Visual Risk Factors
  - Glare
  - Workstation Layout
  - Uncorrected visual disorders
  - Prolonged, uninterrupted viewing
  - Display quality

Introduce the primary visual risk factors and how each of the coming slides will demonstrate each of these factors.
Interesting note the background of the slide blends into the picture due to the excessive glare.
Visual Ergonomics

- Visual Risk Factors
  - Indirect Glare
Good moment to introduce the concept of the body following the eyes. The placement of each piece of equipment can fatigue the eyes but will also impact other body parts as will be discussed in the following sections.
Visual Ergonomics

- Visual Risk Factors
  - Uncorrected visual disorders
    • Astigmatisms
    • Nearsightedness, farsightedness
  - Prolonged viewing times
    • Staring through microscope lens
    • Staring at computer monitor
  - Display Quality
    • Adjustment of brightness and contrast controls
    • Adjustment of focal controls

Address the issues surrounding each of these risk factors. Particularly the importance of eye exams each year. Poll the last time each person had an exam.
Visual Ergonomics

- Controlling Visual Risk Factors
  - Adjust height, tilt and placement of monitor

Demonstrate the correct placement of monitors using the provided equipment.
Visual Ergonomics

• Controlling Visual Risk Factors
  – Install window treatments and reposition task lights

Address the correct usage of each device.
Visual Ergonomics

• Controlling Visual Risk Factors
  – Clean monitor/microscope regularly and use anti-glare screens
Address the importance of the correct distance to the monitor and why. I.e the eye has a tendency to gaze slightly down when relaxed.
Visual Ergonomics

• Visual Summary
  – Controlling Risk Factors
    • Workstation Arrangement
    • Adjust Window Covering
    • Position or Adjust Task Lights
    • Adjust Monitor Tilt
    • Avoid Reflective Surfaces
    • Use a Hood or Glare Screen

Ensure the staff understand how each modification controls the different risk factors. Take time to discuss how they can apply these principles in their work environment.
Visual Ergonomics

- Visual Summary
  - Visual Setup
    - Place Top of Screen Just Below Eye Level
    - Use a Document Holder
    - Place Document and Monitor at Comfortable Viewing Distances
    - Consider Your Dominant Eye

Continue with the summary. Demonstrate to staff how to find their dominant eye.
## Visual Ergonomics

- **Visual Summary**
  - **Health and Comfort Strategies**
    - Have Regular Eye Exams
    - Yawning / Blinking
    - Palming
    - Focus Change
    - Massage
      - Eye
      - Head (back, forehead, and side)

---

Perform demonstration with students of alternate health and comfort strategies and how they can assist the staff to be more comfortable. Describe how we blink less often when reading and using computers and how these strategies can be used to address this risk.
Exam time! Staff should identify the risks in this photo and how they should be addressed. Project is meant to reinforce the information that was given in the preceding section. Discuss any problems staff had and how to resolve them. Introduce the next section once staff feel comfortable with this information.
General Ergonomics

- Shoulder and Neck Concerns
  - Arm pain
  - Tension in shoulders or neck
  - Tendonitis
  - Shoulder or neck discomfort

Poll students on numbers experiencing these symptoms and use in same manner as previous section.
General Ergonomics

• Shoulder and Neck Risk Factors
  – Poor Posture (e.g. bent neck)
  – Inappropriately adjusted equipment (e.g. monitor set to low)
  – Workstation Layout (e.g. reaching postures)
  – Stress and Muscular tension

Link these risk factors to the general risks factors discussed earlier. The next slides will be samples of common hazards in the work environment.
General Ergonomics

- Shoulder and Neck Risk Factors
  - Poor Posture
General Ergonomics

- Shoulder and Neck Risk Factors
  - Inappropriately Adjusted Equipment
General Ergonomics

• Shoulder and Neck Risk Factors
  – Workstation Layout
Demonstrate with a student the appropriate posture for the use of computers.
Reference back to when there was discussion of the body following the eyes and how that may impact the neck and shoulders.
General Ergonomics

- Controlling Shoulder and Neck Risk Factors
  - Workstation Layout

Use the provided equipment to demonstrate with a staff member how the work environment should be organized.
Get staff to demonstrate the health and comfort strategies. Emphasize extreme caution when performing any neck stretches.
General Ergonomics

- Evaluation of Risk Factors

Test time! Work in groups to identify risks and possible solutions. Discuss as a group upon completion.
If the first slide was addressed appropriately by mist groups this slide can be summarized by the instructor. If not break into different groups and perform the exercise again. Introduce next section on arm and wrist concerns.
General Ergonomics

- Arm and Wrist Concerns
  - Tendonitis
  - Bursitis
  - Carpal Tunnel Syndrome
  - Repetitive Strain Injuries

Poll students and use the information as was used in the previous sections.
Again link to general ergonomic risk factors. Ask the students if they understand how these same risk factors can be applied in any situation. I.e. The repetitive nature of the sections. By understanding the risk factors each student should be able to view a work environment and apply there knowledge to reduce risks in each body part.
General Ergonomics

- Arm and Wrist Risk Factors
  - Repetitive Motions
Use some humor! Make students understand that excessive force can be used in typing and weight lifting.
General Ergonomics

• Arm and Wrist Risk Factors
  – Awkward Postures

Introduce the risk factor
General Ergonomics

- Arm and Wrist Risk Factors
  - Hard Edges

Introduce the risk factor.
Correct usage of assistive devices is important.
General Ergonomics

- Controlling Arm and Wrist Risk Factors
  - Alternate Equipment

Equipment is not the only solution. Addressing behaviors such as posture and habits will be more effective. Use as a lead in to stressing the importance of using this information if they want to see any benefits.
General Ergonomics

- Controlling Arm and Wrist Risk Factors
  - Health and Comfort Strategies
    - Fist Release
    - Hand Shake
    - Massage

Have all staff demonstrate the health and comfort strategies.
Test time! Perform as was done in previous sections. Ensure students understand and can use the information. Introduce next section on back and leg risk factors.
Poll students and use as was done in previous sections. Introduce symptoms and use as was done in previous sections.
General Ergonomics

• Back and Leg Risk Factors
  - Awkward/Twisted Postures
  - Inappropriately Adjusted Equipment
  - Workstation Layout
  - Excessive Reaches
  - Static Postures
  - Unsupported Feet
  - Stress and Muscular Tension

Introduce the concept that the back is similar to the other body parts but also it is susceptible to being static and may experience discomfort as a result.
How we should sit and how we do sit! Introduce intervertebral discs and how these can deform and produce discomfort.
General Ergonomics

- Back and Leg Risk Factors
  - Twisted Awkward Postures
General Ergonomics

• Back and Leg Risk Factors
  – Inappropriately adjusted equipment or layout
General Ergonomics

- Back and Leg Risk Factors
  - Excessive Reaches
General Ergonomics

- Controlling Back and Leg Risk Factors
  - Proper Posture

Use a staff member to demonstrate the proper posture and how there can be variation while still maintaining appropriate angles.
General Ergonomics

- Controlling Back and Leg Risk Factors
  - Equipment adjustment
General Ergonomics

- Controlling Back and Leg Risk Factors
  - Proper foot and leg support
General Ergonomics

- Controlling Back and Leg Risk Factors
  - Health and Comfort Strategies
    - Movement
    - Cable Stretch
    - Knee Raises
    - Shoulder Shrug, Rotation and Stretch
    - Neck Stretch
    - Foot Rotation and Toe Points
    - Massage

Have staff demonstrate the health and comfort strategies.
Test time! Break into groups as was performed in previous sections.
Ask staff if they feel comfortable applying the information given in the previous section to their work environment. This section will demonstrate specific microscope risk factors and the students will determine how they should be addressed.
Microscope Ergonomics

- Why is it important to focus on good ergonomic practice when working with microscopes?
  - 70.5% of Washington Cytotechnologists reports some form of neck, shoulder or back discomfort. (ASCT website)
  - 84% of microscopists in the Stockholm county hospital experience job related musculoskeletal pain. (Rizzo, Rossignol and Gauvin, 1992)

This is background information on why this course is important and why it is vital that they change their behaviors and apply what they have learned. Also they face the same risks other microscope users around the world face.
Microscope Ergonomics

• Why the need for good ergonomic practice?
  – Microscope work contains many of the risk factors that are present in other workplaces that can lead to discomfort or injury.
  – A survey and interviews with staff members shows that CLS has similar ergonomic problems as other labs reported on in the literature.
  – Failure to address ergonomic risk factors may lead to higher injury rates and reduced productivity.

Again stress the importance of making a change in how they perform their work tasks.
Microscope Ergonomics

- What body parts are affected by pain or discomfort at CLS?
  1. Neck discomfort
  2. Head discomfort (eyestrain/headaches)
  3. Shoulder discomfort
  4. Arm/hand/wrist discomfort
  5. Back discomfort
  6. Leg/foot discomfort

Results of the questionnaire at CLS
Microscope Ergonomics

- Microscope Risk Factors
  - Prolonged awkward neck and back postures while viewing samples
  - Unacceptable wrist postures to manipulate samples and adjusting microscope controls
  - Mechanical stress to the elbows, forearms and wrists while manipulating samples and adjusting microscope controls
  - Prolonged viewing leading to headaches and visual strain
  - Lack of lumbar support leading to neck shoulder and lumbar pain

Demonstrate how these risk factors are no different than the ones already discussed in the course.
Microscope Ergonomics

- Prolonged awkward neck and back postures

Examples from CLS
Microscope Ergonomics

- Unacceptable wrist postures
Microscope Ergonomics

- Mechanical stress

Examples from CLS
Microscope Ergonomics

- Poor support leading to neck shoulder and back pain
Microscope Ergonomics

- Controlling microscope risk factors
  - Microscope workstation design
    - Neck flexion no greater than 30 degrees
    - Upper arm vertical, forearms horizontal and supported on the work surface
    - Wrists held in neutral posture
    - Keep back supported in neutral position
  » Helander et al 1991

Material specific to microscope use. To be used in addition with material already discussed.
Samples of changes at CLS. Discuss ideas for other changes that can be used to make the environment more ergonomically friendly.
Microscope Ergonomics

- Controlling Microscope Risk Factors
  - Forearms supported on work surface
Microscope Ergonomics

- Evaluation
  - Good
  - Bad

Test time. Write out responses individually then poll the students.
Microscope Ergonomics

- Evaluation
  - Good
  - Bad
### Ergonomic Resources

- **Resources on the web**
  - www.ewiworks.com
  - www.openerg.com
  - www.ergo.human.cornell.edu/
  - www.me.berkeley.edu/erg/services/tips.html
  - www.ncerc.com
  - www.cdc.gov/niosh
  - www.alimed.com
  - www.cssinfo.com

Information websites included in resource manual.
The End

Questions?

Address issues, questions or concerns staff have with the course. The next element is using the equipment in the classroom to design a workstation for the tallest and smallest members of the training group. Split the group into two and have them work together to complete the station. Afterwards have each group critique the good and bad elements of each station as they have been designed. Encourage creativity. At the end of the session stress the importance of going back to their stations and making positive changes to their work environment.
Appendix 8
Course Evaluation

Thank you for taking the time to fill out this evaluation form. As this is the first time this course has been given your comments will be vital for improving the course for future participants.

Course Information
Date: ____________________________ Course Name: ____________________________
Instructor Name: ____________________________

Overall Assessment

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Average</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How would you rate the course overall?</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>2. How effective was the course in achieving the stated objectives?</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>3. How would you rate the methods used to achieve the course objectives? (Lecture, slides, evaluation pictures, and sample workstation adjustment)</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>4. How would you rate the reference materials handed out during the course?</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

Detailed Assessment

5. In your opinion what was the most effective part of the training course? ____________________________________________

6. In your opinion what was the least effective part of the training course? ____________________________________________

7. What changes would you make to improve the training course for future participants? ____________________________________________

8. Will the material that was handed out to you be helpful in modifying your work area? ____________________________________________

9. Will you be able to apply what you have learned in this training course to your work area? ____________________________________________

10. Additional comments (use other side if necessary)? ____________________________________________

Please Return to Course Instructor