Determining the Need for an Expanded Fitness Component in the Fire Science Program at Milwaukee Area Technical College

by

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ABSTRACT

The fire service is one of the most dangerous occupations in the world. Firefighters are exposed to extremely hostile environments in which they have to perform arduous physical activity while wearing and using 50 to 100 pounds of clothing and equipment. This physical activity remains constant throughout a firefighter's 25-plus year career.

Hands-on training and actual firefighting are too infrequent to solicit a training effect. Therefore, a firefighter must possess and maintain his/her ability through other means. This study will look at the physical ability of fire science students enrolled at Milwaukee Area Technical College and compare them to the abilities of incumbent firefighters with the purpose of determining the need to expand the physical fitness portion of the MATC Fire Science Curriculum to meet the needs of students and the fire service.

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Chapter 1: Research Problem and Objectives

Introduction

Milwaukee Area Technical College (MATC) is the largest technical college in the state of Wisconsin (MATC, 2005). The total student annual enrollment is approximately 64,000. It is a publicly supported, comprehensive higher education institution. The MATC district, the largest of 16 technical school districts in the state of Wisconsin, includes Milwaukee County, most of Ozaukee County, and parts of Waukesha and Washington counties. The total population of the district served by MATC is approximately 1.25 million.

MATC is governed by a nine-member board, which is comprised of district residents. These board members are appointed by elected officials from the 21 school districts that exist in the district.

The vision statement of MATC is that the college is committed to being a world-class educational institution that empowers students, faculty, and staff to realize their potential (MATC, 2005).

MATC's mission statement is that it is a publicly supported, comprehensive higher education institution committed to increasing the potential and productivity of the people in its district through the delivery of high quality instruction and programs that are consistent with current and emerging educational and labor market needs (MATC, 2005).

MATC is accredited by the North Central Association of Colleges and Schools, Commission on Institutions of Higher Education. It is also a member of the American Association of Community Colleges. In addition, MATC academic programs are

accredited, approved, and/or governed by numerous organizations and agencies that exist in the community (MATC, 2005).

MATC offers a wide variety of educational opportunities to its students (MATC, 2005). These include:

- Associate in Applied Arts Degree
- Associate in Applied Science Degree
- Associate in Arts Degree
- Associate in Science Degree
- Technical Diplomas
- Adult High School Diplomas
- Certificates
- Advanced Technical Certificates
- Bilingual Education
- Continuing Education Courses
- Career Courses-Degree and Technical Diploma Credit
- Career Courses-Continuing Education Credit
- Personal Enrichment Courses
- Apprenticeships
- Cooperative Education/Internships
- MATC Honors Program

One of the areas of study available at MATC is in Fire Science. The Fire Science program offers a layered program of training, certification, and education. The Fire Science program offers the following programs to its student population (MATC, 2005):

- Associate in Applied Science Degree-Fire Science
- Firefighter Certification
- Fire Officer Certification
- Driver/Operator Certification
- Firefighter Intern Program
- Customized Training

Students in the fire science program participate in one or more of the above programs, depending on their needs and/or goals.

The mission of the Milwaukee Area Technical College Fire Science Program is to prepare students for a career in the fire service, and to meet the needs of the communities MATC serves (MATC, 2005). This is accomplished through the use of the programs listed above, the use of the training facility located at the south campus of MATC, and a cooperative effort between MATC and the Milwaukee Fire Department, which allows MATC to train students from its northern communities at its training facility.

The learning environment of the fire science program includes a wide variety of traditional classroom and hands-on activities. Facilities available for use include:

- Classrooms
- Simulated Fire House (MATC south campus and MFD academy)
- Burn building
- Splashboard
- Flashover Simulator

Fire Science is a two-year Associate in Applied Science Degree program offered annually at MATC. Upon completion, students may enter the workforce, or continue their

education by pursuing a Bachelors Degree in Fire Science at one of several four year institutions with which MATC has an articulating agreement. The Fire Science program prepares students for a wide variety of careers in the fire service which can include:

- Firefighter
- Emergency Medical Technician
- Driver/Operator
- Fire Officer
- Fire Inspector
- Fire Investigator
- Fire Chief

These career paths are available for students as members of volunteer of professional fire departments.

The MATC Fire Science program is supervised by an Associate Dean, who is responsible for all Protective Services programs. The instructional staff includes two full-time instructors that teach exclusively in the Associates Degree program and twenty-eight part time instructors that may teach in all areas of education offered, including Associates Degree and certification classes, as needed. All members of the instructional staff are current or former members of fire departments, as well as being Wisconsin State Certified Instructors.

The primary responsibility of the instructional staff is the delivery of effective education, that meets the needs of the students, community and fire service. In addition, instructors may be assigned additional duties such as proctoring certification exams, and curriculum development.

The sixty-five credit Associate in Applied Science Degree program requires the completion of 33 credits in Technical Courses (Fire Science), 26 credits in General Education Courses, and 6 credits in Elective Courses (MATC, 2005). The Technical Courses currently offered include:

- Fire Protection Organization
- Building Construction and Fire Ordinances
- Fire Protection Water Systems
- Fire Fighting Tactics and Strategy 1
- Fire Department Health and Safety
- Chemistry of Hazardous Materials
- Fire Prevention, Inspection, and Protective Systems
- Fire Department Management 1
- Fire Investigation
- Disaster Management and Planning

These courses have been taught since 2001.

Statement of the Problem

The Fire Science Curriculum at Milwaukee Area Technical College meets the standards set forth by the National Fire Administration and the State of Wisconsin. It provides an exceptional education in the diverse fields of knowledge required for success in a career as a firefighter. The knowledge gained by the students provides them with a strong academic foundation in fire service practices and theory.

Firefighting is one of the nations most dangerous and hazardous jobs with heart attacks, high physical stress levels, and injury all common occurrences (USFA, 2004).

Each year approximately 100 firefighters lose their lives and thousands are injured while performing their duties in fire suppression and emergency medical services (NFPA, 2004).

While the Fire Science Curriculum does a great job educating its students academically, little emphasis is placed on preparing them physically for a career in the fire service. A method of determining the need for a fitness component in the Milwaukee Area Technical College curriculum needs to be determined and applied to provide for the safety of our students as they enter their chosen field.

Objectives

This study was designed to reach the following objectives:

1. Identify the different methods, through research, of evaluating firefighter physical performance and fitness, and determine which one would be the best evaluation tool to ascertain the need for a fitness component in the Milwaukee Area Technical College Fire Science program.
2. Compare, through research, the fitness levels of Milwaukee Area Fire Science students to an existing standard to determine the need for a fitness component in the Fire Science Curriculum.
3. Recommend changes or additions to the Fire Science Curriculum to provide a fitness component based on the results of this study.

Significance of the Study

An individual preparing for a career in the fire service must be prepared academically to meet the knowledge requirements to be a safe and effective firefighter, as well as physically, to meet the strenuous physical demands of firefighting. These physical

demands manifest themselves during the application process, recruit training, and during a career that can span twenty-five years or more.

Firefighting is one of the most dangerous occupations in the United States. In 2003, 111 firefighters lost their lives while on duty (USFA, 2004). In addition, more than 78,000 suffered injuries that were reported (NFPA, 2004). From 1987 to 2001 there has been a 31% decrease in the incidence of structure fires, while the death rate has hovered around 100 (USFA, 2003). When compared to data from the United States Bureau of Labor Statistics, firefighter job related injury is 4.5 times higher than that of other workers. This means that approximately one out of three firefighters is injured annually (IAFF/IAFC, 1999).

Firefighters' long hours (most work 24-hour shifts, some allow 48-hour shifts), sporadic high intensity work, emotional involvement and exposure to human suffering places firefighting among the most stressful in the world (IAFF/IAFC, 2000). Fire fighters must often go from a state of deep sleep to high intensity physical activity in a matter of minutes (USFA, 2004). This along with long term exposure to chemicals and infectious disease contribute to heart disease, lung disease, and cancer (IAFF/IAFC 2000). Death and injury statistics indicate that the leading cause of firefighter fatalities is heart disease (USFA, 2004). The leading cause of injury is sprains and strains (NFPA, 2004). The majority of these injuries occur on the fire ground. Fifty-five percent of firefighter injuries occur during seven percent of a firefighter's duties, fighting fires (Herbert, 2005).

Research has shown the need for high levels of fitness to perform safely in the fire service (IAFF/IAFC, 2000). Strength is required to perform victim rescue, place ladders,

handle hose lines, and force entry with heavy tools (Hall and Adams, 1998). Victim rescue can require the firefighter to drag, lift, or carry a large victim up and down stairs or a ladder. Ladders can weigh in excess of 150 pounds and hose lines can have nozzle reaction pressures exceeding 100 pounds (Mahoney, 2004, p. 99).

Aerobic and anaerobic endurance is needed to move rapidly down hallways, climb ladders, and combat fires (Hall and Adams, 1998). While most firefighting evolutions are anaerobic in nature, consisting of short duration and high intensity activity, increased aerobic capacity can allow a firefighter to work harder longer (Kraemer, 1994).

Firefighters cannot maintain their fitness levels by fighting fires, because of the declining frequency of fires, work schedules, the nature of the job, and increased demands of the profession. As mentioned earlier, the number of fires in the United States is declining. As the number of fires declines, the opportunities for firefighters to practice their most difficult physical activities occur less frequently. During a 48 hour period from 0800 hours January 31, 2003 to 0800 hours February 1, 2003, Engine Company 10 of the District of Columbia, Washington D.C. Fire Department, the busiest engine company in the United States, spent only ten hours responding to emergencies (Clark and Ballard, n.d.). Also, the majority of these responses were for EMS emergencies. Research has shown that a physical activity must be performed at least twice weekly in order for one to maintain and/or improve one's physical abilities (Stefano, 2000, p. 20).

Firefighters work a unique schedule, 24 hours on, 48 hours off which can also compound this problem (City of Milwaukee, 2005). Any time they have an off day, the firefighter is away from firefighting for 5 days. This occurs approximately twice a month with vacation, personal time off, and sick days.

Even though firefighting is a dangerous occupation, and very physically demanding, the majority of firefighter's duties would be considered sedentary in nature. These would include equipment and building maintenance, building inspections, pre-fire planning, public fire education and the majority of EMS runs (USFA, 2004). This paradox also limits the training effect that a firefighter gets from performing his/her duties to maintain their physical ability during a twenty-five plus year career.

Practical training applications simulating difficult firefighting evolutions could be used to help a firefighter maintain or improve his/her physical ability. However, because of recent budgetary restraints and events like 9-11, firefighter's time for training on firefighting activities has been greatly reduced. "Our customers are demanding more from us in other areas such as fire-based EMS, technical rescue, USAR, haz mat, WMD, bio-terrorism, and so forth" (Herbert, 2005, p. 2). This extra demand, especially because of the increase in EMS responses, demands extra training time, limiting the time available for hands on, physical training to develop one's fitness for firefighting.

For these reasons many fire departments have increased their commitment to fitness and wellness programs for the fire service. Most departments recognize that a fitness program is an essential part of their safety and health program (Angle, 2005). NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* states that a fire department shall establish and maintain a fitness program. NFPA1583, *Standard on Health Related Fitness Programs for Fire Fighters*, states that annual fitness assessments should be done for all firefighters. These however, are standards that do not carry the weight of law. Many fire departments still do not have fitness programs because of budgetary restraints and resistance from fire fighters and unions (Janda, 2004).

Providing MATC Fire Science students with training in fire fighter fitness could provide them with life skills to help them remain safe and effective firefighters throughout their careers.

Most professional fire departments require that the prospective firefighter pass some kind of rigorous physical test as part of the application process. This test is often some kind of "physical ability test" that simulates firefighting activities (Lepore, 2004).

This test is usually pass/fail, and very physically demanding, requiring the applicant possesses the strength and endurance needed for fire fighting. As with any test, applicants that have not prepared themselves can fail, and be denied employment. Adding a fitness component that addresses the physical demands of these entrance tests would alleviate stress from the application process as well as enable individuals that possessed borderline physical ability to be successful.

Individuals that are hired by a fire department are hired on a probationary basis. They are then placed in a full time training situation that can last from just a few weeks to several months. During this time, the recruit is trained to perform all the duties of a fire fighter, based on the fire department's Standard Operating Procedures and Guidelines. These training academies can be the most physically demanding part of a firefighter's life, let alone career. "Many seasoned firefighters will tell you that recruit training was the most exhausting and stressful period of their careers" (City of Milwaukee, 2005, p. 4).

Fire service training, because it simulates actual emergency situations, is inherently dangerous. Raising and climbing ladders, advancing hose lines, using power tools, and fighting training fires pose a high potential for injuries (USFA, 2003). The most dangerous training situation is live fire training. Fires, even in a training situation,

are just as dangerous as at an emergency, yet this type of training is necessary to develop safe and effective firefighters.

In 2003, 7,600 firefighters were injured in training and 11 lost their lives (NFPA, 2004). The most common injuries were sprains and strains of the knee and lower back. This accounts for about 10 % of all injuries and fatalities. The best means of preventing these injuries would be to promote physical fitness (USFA, 2003). Providing MATC fire science students with a fitness background would address this situation and assist them in being successful during this physically demanding part of a firefighter's career.

Limitations of the Study

The limitations of this study are:

1. This study is being developed as part of the Associate in Applied Science Degree for Milwaukee Area Technical College.
2. The results of this study will apply only to fire science students enrolled at Milwaukee Area Technical College.
3. Any suggestions for an expanded fitness program will be for the Fire Science Curriculum at Milwaukee Area Technical College only.

Assumptions of the Study

The assumptions of this study are:

1. The Fire Science Curriculum of MATC is open to change and enhancement.
2. The Associate Dean of MATC Protective Services will review and accept the new course curriculum changes that are indicated and recommended.
3. The MATC Fire Science Advisory Board will review and approve the course curriculum changes recommended.

Definitions of Terms

Milwaukee Area Technical College (MATC) - The largest technical college in the State of Wisconsin (MATC, 2005).

Fire Science – An associate degree program, involving the suppression of incendiary substances, and protecting lives and property through fire prevention and public education (MATC, 2005).

Burn building – A fire-proof building used to train firefighters to extinguish live fires in a controlled environment (Hall and Adams, 1998).

Flashover – A phenomenon that may occur in a fire, where all combustibles ignite simultaneously, releasing a tremendous amount of heat (Angle, 2005).

Protective services – An area of study at MATC that includes Police Science, Fire Science, and Emergency Medical Services (MATC, 2005).

Curriculum – All the courses of study in a school, university, etc. (Costello, 2000).

Fitness – The ability to perform physical activities, such as job tasks, with enough reserve for emergency situations and to enjoy normal activities when off duty (Hall and Adams, 1998).

Aerobic fitness – A measurement of the body's ability to perform and utilize oxygen (Angle, 2005).

Anaerobic fitness – The ability of a muscle to perform during periods of intense physical activity during which an oxygen deficit is incurred (Kraemer, 1994).

Body composition – A measure to show the percentage of fat in the body (Angle, 2005).

Flexibility – The range of motion in a joint, which depends on the extensibility of soft tissues (Stefano, 2000).

Muscular strength – The maximal amount of force a muscle can exert in a single contraction: the ability to apply force (Angle, 2005).

Muscular endurance – The ability of the muscle to perform repeated contraction for a prolonged period of time (Davis and Dotson, 1992).

Firefighter –An individual that provides emergency service to a community in fire suppression, EMS, and technical rescues, as well as non emergency activities such as fire prevention and education; can be a volunteer, paid on call, or professional (Hall and Adams, 1998).

Recruit – A newly hired firefighter in training (City of Milwaukee, 2005).

Training academy - a full time training program for newly hired firefighters (City of Milwaukee, 2005).

Physical ability test - A series of strenuous exercises simulating firefighting events (Lepore, 2004)).

Nozzle reaction pressure – The backward pressure caused by the flow of water from **a** nozzle (Mahoney, 2004, p.99).

Fitness evaluation – An assessment of an individual's fitness level (Berry and Matic, 1998).

NFPA - National Fire Protection Association; publishes standards for the fire service (Angle, 2005).

USFA – Department under the Federal Emergency Management Agency that directs and produces fire programs (Angle, 2005).

Chapter 2: Review of Literature

Introduction

The mission of the Milwaukee Area Technical College Fire Science program is to prepare students for a career in the fire service, and to meet the needs of the communities MATC serves. The primary responsibility of the instructional staff is the delivery of effective education, that meets the needs of the students, community and fire service.

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While the Fire Science Curriculum does a great job educating its students academically, little emphasis is placed on preparing them physically for a career in the

fire service. A method of determining the need for a fitness component in the Milwaukee Area Technical College curriculum needs to be determined and applied to provide for the safety of our students as they enter their chosen field.

History of Fitness in the Fire Service

Firefighter fitness is an issue that has met with a lot of resistance from the fire service (IAFF/IAFC, 2000). Firefighters were afraid that they could lose their jobs if they could not meet certain standards, unions agreed and resisted their implementation, and communities balked at the high initial start up costs.

For these reasons, for many years the only evaluation of a fire fighter's physical ability was the pre-employment physical ability test and his/ her job performance. Injury and death were accepted as part of the occupation (Angle, 2005).

In 1987, the National Fire Protection Association (NFPA) adopted its *Standard on Fire Department Occupational Safety and Health Program.* This document included a section on fire fighter fitness. It stated that a fire department should establish and provide a physical fitness program and require participation (NFPA, 1997).

The International Association of Fire Fighters and the International Association of Fire Chiefs published *The Fire Service Joint Labor Management Wellness-Fitness Initiative* in 1997. This document was the first time labor and management worked together to develop a program to benefit the fire service. This document includes an outline for a fire service fitness program. The initiative also developed the "Candidate Physical Ability Test" (CPAT) to be used as a test of a prospective firefighter' physical ability (IAFF/IAFC, 1999).

The NFPA also adopted NFPA1583 *Standard on Health-Related Fitness Programs for Fire Fighters*, which outlines fitness evaluations and program development for incumbent fire fighters (NFPA, 2000). Subjects include the duties of the health and fitness coordinator, fitness assessments, exercise and fitness training programs, health promotion education and data collection.

These developments have created renewed interest in firefighter fitness. Many departments have or are implementing a fitness program. The fire service has recognized that fitness is one way of reducing the number of injuries that occur in the fire service at an alarming rate. A firefighter that possesses the level of fitness required by fire fighting is safer, more productive, easier to train and less costly to retain.

How to determine the physical ability of an individual to perform the duties required of a firefighter is a subject that has been and still is debated. One method to determine the fitness of a fire fighter is to use a test that simulates the physical and mechanical demands of firefighting. These tests have been referred to as physical ability tests, physical agility tests, and combat tests (IAFF/IAFC, 1999). This document will refer to them as physical ability tests. Another method to determine an individual's fitness to participate in the occupation of firefighter is through the use of a fitness evaluation, using standard physical fitness tests (Davis and Dotson, 1992).

Physical Ability Tests

The fire service uses many different physical ability tests to determine the fitness level of applicants as well as incumbent firefighters (Lepore, 2004). Although each is different they are all similar in that they test the individual's muscular strength, muscular

endurance, and aerobic capacity. The following physical ability tests were researched and will be discussed:

- "The Pack Test" (USDA, 2002)
- Biddle Physical Ability Test (Chabot College, n.d.)
- Combat Challenge (Davis & Dotson, 1992)
- City of Milwaukee Physical Ability test (City of Milwaukee, 2005)
- Candidate Physical Ability Test (IAFF/IAFC, 1999)

The Pack Test refers to work capacity tests used to qualify potential wildland firefighters for the three different levels of firefighting duty:

- Arduous: involves the field work which requires above average endurance and strength which all firefighters are required to perform.
- Moderate: involves field work requiring complete control of physical faculties, walking long distances, standing, and lifting 25-50 pounds.
- Light: involves mainly office work. (USDA, 2002)

The pack test is designed to measure a firefighter's aerobic capacity, muscular strength, and muscular endurance (USDA, 2002). The level of fitness designated for a firefighter's duties must be maintained to provide for safety and operational effectiveness.

The test criteria for the different fitness levels required for the different levels are:

- Arduous: a 3-mile hike with a 45 pound pack completed in 45 minutes
- Moderate: a 2-mile hike with a 25 pound pack completed in 30 minutes
- Light: a 1-mile hike completed in 16 minutes with no pack (USDA, 2002)

Testing Protocols include:

- Testing is monitored for safety
- No jogging or running
- Test is pass/fail
- You may use your own pack or a standard firefighter backpack pump provided
- Packs are weighed before and after the test (USDA, 2002)

The Pack Test is a one dimensional test which does not utilize any activities a firefighter would participate in while performing his/her duty except for walking under load. It is primarily used to evaluate wildland firefighters. Individuals taking the test are encouraged to train at least four to six weeks prior to taking the test.

The Biddle Physical Ability Test is offered at Santa Ana College in Orange County, California (Chabot College, n. d.). It is part of the hiring process of many Southern California Fire Departments. It consists of 11 separate tasks that simulate tasks consistent with the duties of a firefighter (Santa Ana College, 2005). The 11 tasks include:

- Event 1: Dry Hose Deployment in which the participant advances three sections (150 feet) of uncharged 1 ¾ inch hose around two obstacles and a corner.
- Event 2: Charged Hose Deployment in which the participant advances three sections of charged 1 ¾ inch hose 70 feet, having to stoop or crawl 32 feet of the course because of obstruction.
- Event 3: Halyard Raise in which the participant raises and lowers the fly section of a 35–foot aluminum extension ladder using a hand-over-hand method.

- Event 4: Roof walk in which the participant ascends and descends a 12-foot roof ladder carrying a simulated 20 pound chain saw.
- Event 5: Attic Crawl in which the participant crawls 20 feet across an attic prop while carrying a simulated flashlight in their hand.
- Event 6: Roof ventilation in which the participant must strike a target using an eight pound sledge hammer 30 times while standing on a slant roof prop.
- Event 7: Victim Removal in which the participant carries or drags a 154 pound manikin 26 feet making a 180 degree turn around a cone at the midpoint.
- Event 8: Ladder Removal/Carry in which the participant removes a 24 foot aluminum extension ladder weighing 72 pounds from mounting hooks and carries the ladder around a diamond shaped course 54 feet placing the ladder in its original position.
- Event 9: Stair Climb with Hose in which the participant carries a 50 pound hose pack up four flights of stairs.
- Event 10: Crawling Search, in which the participant crawls on the platform of the fourth floor 60 feet, then picks up the 50 pound hose bundle returning to the ground floor.
- Event 11: Hose Hoist in which the participant carries two air cylinders connected by a shoulder strap weighing 29 pounds to the third floor, sets them down and then hoists 100 feet of 1 ¾ inch hose with an attached nozzle up to the third floor and then pulls the entire length of hose over the railing. He/ she then returns to the ground floor carrying the two air bottles.

All of the described events are done in sequence while wearing a firefighter turnout coat, breathing apparatus shell and bottle, helmet and firefighting gloves. Participants must walk from one event to the next. The Biddle Physical Ability Test must be completed in 9 minutes 34 seconds or less to pass.

This test simulates many tasks required of a firefighter in performing his/her duties. While it is pass/fail it is very physically demanding and requires that the participant possess a minimum ability required for firefighting. It requires specialized equipment and test props for its performance.

The "Combat Challenge", developed by Paul Davis Ph.D. and Charles Dotson Ph.D. of ARA Human Factors was a very popular physical ability test used extensively in the 1990s and still used today by some fire departments. It consists of five tasks which simulate the demands of firefighting (Davis & Dotson, 1992). These events include the following.

- Task 1: High Rise Stair Climb Evolution in which the participant carries a high rise hose pack consisting of three sections of 1 ½ inch hose to the fifth floor of a tower and placing it in the designated area.
- Task 2: Hose Hoist in which the participant hoists a 50 foot section of 2 ½ inch hose to their position on the fifth floor using a ½ inch diameter utility rope. He/she then returns to ground level using each step.
- Task 3: Forcible Entry Evolution in which the participant drives the Keiser Forcible Entry Simulator I-beam five feet using a nine pound sledge hammer by striking the end of the I-beam.

- Task 4: One and ½ inch Hose Advance in which the participant walks 140 feet, picks up the charged hose line, advances it 40 feet and then opens the nozzle to momentarily discharge water.
- Task 5: Victim Rescue in which the participant must lift and/or drag a 175 pound manikin 100 feet.

Participants in the Combat Test wear full firefighter turnout gear while breathing from a self-contained breathing apparatus (Davis & Dotson, 1992). Running is only allowed during the hose drag portion of the test. An acceptable time on the test is seven minutes. It was recommended that this test be used competitively, with results based on completion times. Awards could be given for times under five minutes (gold) and seven minutes (silver).

This test is very physically demanding because of its competitive concept. It was and still is a highly attended competition seen on ESPN (Davis, n. d.). It has fallen out of favor with the IAFF and many firefighters due to the potential dangers when used as a competitive fitness tool (Angle, 2005).

The City Of Milwaukee developed and has used their Physical Ability Test for approximately fifteen years (City of Milwaukee, 2005). The test is only used during a fire fighter hiring period which occurs every two to three years. It consists of seven events which simulate firefighter activities at the scene of a fire:

- Ladder Climb: participants climb a 35 foot extension ladder to the third floor of the training tower and then descend to ground level using an outside fire escape.
- Hose drag: participants drag an uncharged, accordion folded 2 ½ inch hose line with an attached nozzle 200 feet.

- Chopping Simulation: participants strike a target on an incline board with an eight pound sledge hammer 50 times.
- Pike Pole simulation: participants use a twelve foot pike pole to alternately poke and pull a board suspended overhead 20 times.
- Participants take a horizontal 24-ft. extension ladder from a 30 inch high rack, place it on a shelf 57 inches from the ground and then replace it on the lower rack.
- Manikin Crawl: Participants move a 125 pound manikin from a table to the ground and then through a simulated tunnel. The manikin must then be lifted back onto the table.

Participants must wear a firefighter turnout coat, approved fire helmet, and self contained breathing apparatus harness and bottle for a total weight of approximately 45 pounds (City of Milwaukee, 2005). The test is pass/fail with a time of seven minutes thirty seconds as passing. Unlike other tests, participants are allowed to run on the course. It was originally used as a competitive test and has evolved into a pass/fail test.

The Candidate Physical Ability Test developed in a cooperative venture between the IAFF and IAFC as part of the *Joint Wellness-Fitness Initiative* is the most commonly used physical ability test in the United States (IAFF/IAFC, 1999). It is used by many fire departments as a part of their application process. Some fire departments administer the test themselves, some hire the process out to a test site, and some require an applicant to have a current certificate of completion in order to apply.

The CPAT consists of eight separate events designed to simulate the physical demands of firefighting (IAFF/IAFC, 1999). Each participant is required to wear long pants, a hard hat, work gloves and closed toe shoes. In addition each participant wears a

weighted 50 pound vest to simulate the weight of fire fighter protective clothing and an SCBA.

- Event 1: Stair Climb in which the participant walks on a Stepmill stair-climbing machine for a 20 second warm-up at 50 steps per minute and then three minutes at 60 steps per minute. In addition the participant wears two 12.5 pound weights on the shoulders to simulate the weight of a hose pack.
- Event 2: Hose Drag in which the participant grabs a nozzle attached to 200 feet of uncharged 1 ¾ inch hose and drags it 75 feet to a barrel, makes a 90 degree turn around the barrel and continues for an additional 25 feet where they drop to one knee and drag 50 feet of hose to their position using a hand-over-hand motion.
- Event 3: Equipment Carry in which the participant removes two saws one at a time from a cabinet, places them on the ground, picks one up in each hand and carries them 75 feet around a drum returning to the starting point. The saws are then returned to the cabinet one at a time.
- Event 4: Ladder Raise and Extension in which the participant raises a 24-foot extension ladder against a building and then extends and lowers the fly section of a second pre-positioned ladder using a hand-over-hand motion on its halyard.
- Event 5: Forcible Entry in which the candidate must strike a measuring device with a sledge hammer until a buzzer sounds.

- Event 6: Search in which the participant crawls through a tunnel maze three feet high and four feet wide that contains obstacles and two 90-degree turns, a distance of 64 feet.
- Event 7: Rescue in which a 165 pound manikin is dragged using its handles 35 feet around a barrel and then 35 feet back to the finish.
- Event 8: Ceiling Breach and Pull in which the participant first pushes up on a weighted hinged door using a pike pole three times and then pulls down on a weighted ceiling device five times. This process is repeated four times.

Each CPAT event is separated by a distance of 75 feet (IAFF/IAFC, 1999). Participants may only run during the hose drag portion. The participant is successful if they complete the course correctly in ten minutes twenty seconds or less. The test is pass/fail. One of the requirements of the CPAT is that the participant be offered an orientation at least eight weeks before the test in which the participant can get some hands-on practice. Participants are also given a preparation guide to assist them in their training.

The CPAT requires specific, relatively expensive equipment for its administration. In addition, only accredited testing sites can administer the test. The cost for the CPAT is $100.00 at a local testing site (City of West Allis, 2005).

Fitness Evaluations

Another recognized method of determining the fitness and performance abilities of a firefighter is through the use of a fitness evaluation. While fitness evaluations are widely used at health and fitness clubs, they have been slower to catch on in the fire service. In recent years fitness evaluations have become a required element in fire service

wellness programs. NFPA 1583 and the IAFF/IAFC Labor Management Fitness-Wellness initiative state that fitness evaluations should be a mandatory part of a fire department's fitness wellness program. Common elements of fitness evaluations include aerobic capacity, muscular strength, muscular endurance and body composition tests. Some programs also include a flexibility assessment. Fitness evaluations are used for both fire recruits and incumbent firefighters. This study will examine the following fitness evaluations recommended and used in the fire service:

- "On Target" (Davis & Dotson, 1992)
- Mesa Fire Department Wellness Team Firefighter Fitness Evaluation Program (City of Mesa, 2004)
- The Fire Service Joint Labor Management Fitness Evaluation (IAFF/IAFC, 2000)
- "Professional Fire Profiles: Physical Ability Evaluation" (Berry & Matic, 1998)

The "On Target" program was developed in conjunction with the Combat Test discussed earlier in this study. It could be used as a tool to evaluate fitness alone, or in combination with the Combat Test. On Target was part of a *Certified Fitness Coordinator Training Program* developed by ARA Human Factors (Davis & Dotson, 1992). The program used a target to rate an individual's performance in five different fitness categories and then combined the ratings to achieve a total score which could then be rated on a scale from excellent to poor. The fitness categories and how they were tested included:

- Aerobic Capacity – cycle ergometer, one mile walk, 1.5 mile run, treadmill test, step test
- Muscular Strength – grip strength using a hand grip dynamometer
- Muscular Endurance – a combined score of the maximum number of push-ups completed and a two minute sit-up test
- Body Composition – Neck and waist circumference measures were obtained using a Gulick measuring tape, added, and the body fat percentage obtained from a conversion chart
- Flexibility – sit and reach test

This program allowed the individual to have his/her fitness assessed and compared to existing norms (Davis & Dotson, 1992). Strengths and weaknesses could be found and addressed accordingly. However, because of its association with the Combat Test, the On Target program has lost its popularity.

The Mesa, Arizona Fire Department has developed a Fire Fighter Fitness Program as part of its Wellness Team (City of Mesa, 2004). The fitness evaluation is designed to measure a firefighter's fitness level and provide guidance for improvement when necessary. All members that are required to use a Self Contained Breathing Apparatus must participate in this program. Fitness evaluations are conducted confidentially, annually for all ranks. The scoring system used was developed by Health Methods Inc. Scoring ranks range from excellent to poor. The following fitness components are tested using the described methods:

- Sub-Max Aerobic Capacity Measurement using a treadmill and the Gerkin protocol.

- Body Composition using body-weight, skin fold body fat estimates, and body mass index measurements.
- Muscular Strength using a hand grip dynamometer.
- Muscular endurance using crunches performed at a 30 per minute pace and push-ups performed at a 40 per minute pace.
- Flexibility using a sit and reach protocol.

Each individual that is evaluated participates in a post evaluation consultation (City of Mesa, 2004). Individuals are required to achieve a score of fair or higher. Individuals failing to achieve this level are placed under the supervision of a Health Fitness Instructor. If an individual is unable to complete one of the fitness evaluation elements, he/she must receive an evaluation from their private physician stating their work status, indicating a punitive element.

The *IAFF/IAFC Joint Labor Management Fitness-Wellness Initiative* has developed a firefighter fitness evaluation that is recommended for use as a fitness program for the fire service (IAFF/IAFC, 2000). The program they suggest is similar to those previously described. The one major difference is that it does not grade, rank, or score its participants and is non-punitive. It is to be used only as a tool to help the individual firefighter improve. The fitness elements it suggests evaluating and methods are as follows.

- Aerobic Capacity using the Gerkin Treadmill Protocol or the FDNY Stairmill Protocol
- Muscular Strength using a hand grip dynamometer, arm dynamometer, or leg dynamometer using Wellness-Fitness Initiative Protocols.

- Muscular Endurance Using Wellness-Fitness Initiative Protocols for push-ups and curl-ups.
- Flexibility using Wellness-Fitness Initiative Sit and Reach Protocol.

This Initiative states that "all uniformed personnel shall participate in a mandatory, annual, non-punitive and confidential fitness assessment" (IAFF/IAFC, 2000). Information gathered can be compared to previous assessments if they exist to show improvement and to develop a plan for improvement. The individual firefighter has nothing to compare their individual results against.

The *Professional Firefighter Profiles Physical Ability Evaluation* was developed by members of the Milwaukee Fire Department and has been used to evaluate fire recruits for the last fifteen years (Berry & Matic, 1998). Each recruit is evaluated four times during their probationary period; three times during their eighteen week training academy (beginning, middle, and end) and after fifteen months of service. Each participant receives an individual evaluation and consultation following each evaluation as well as an individualized workout regime that they must participate in during supervised work-outs while in training. The following fitness information is gathered and tests are used during the evaluation:

- Physical Size Profile using height, weight and lean body mass measurements.
- Strength Profile using a bench press and lat pull one repetition maximum estimate, and a grip strength using a hand grip dynamometer for muscular strength.

- Fitness profile using a five-minute step test for aerobic capacity, a one minute sit-up test for muscular endurance, and a one site skin fold test to determine percent body fat and calculate lean body mass.

An individual score is determined for each profile identified above. In addition a final composite score, the "Fire-Power-Index", is determined by combining the three profile scores (Berry & Matic, 1998). Each score can be compared to percentile norms statistically calculated for the fire service. In addition, a data base including period one test results for ten recruit classes from 1992 to 1998 allows analysis of individual test results. Information includes mean, median, range and standard deviation for each test result, profile score and Fire-Power-Index score.

The premise of this program is that while individual tests can be good indicators of a firefighter's physical ability, it is the combination of abilities (muscular strength, muscular endurance, aerobic capacity, and body composition) that determine a firefighter's effectiveness (Berry & Matic, 1998). The Milwaukee Fire Department uses the program to assist all of its recruits in passing its very rigorous academy as well as a safety tool to identify any weaknesses at the beginning of training. Any deficiencies discovered are addressed with individually prescribed additional training and/or increased supervision during dangerous evolutions.

Summary

Assessing firefighter fitness is a topic that is gaining in importance and acceptance in the fire service. Although still meeting resistance from firefighters and unions because of labor issues, and management because of cost, it is recognized as part

of the *Wellness Fitness Initiative*. Firefighter fitness can be determined using physical ability tests or fitness evaluations, each of which can be effective.

Chapter 3: Research Methods

Introduction

The mission of the Milwaukee Area Technical College Fire Science program is to prepare students for a career in the fire service, and to meet the needs of the communities MATC serves. The primary responsibility of the instructional staff is the delivery of effective education, that meets the needs of the students, community and fire service.

While the Fire Science Curriculum does a great job educating its students academically, little emphasis is placed on preparing them physically for a career in the fire service. A method of determining the need for a fitness component in the Milwaukee Area Technical College curriculum needs to be determined and applied to provide for the safety of our students as they enter their chosen field.

Firefighting is one of the nation's most dangerous and hazardous jobs with heart attacks, high physical stress levels, and injury all too common (USFA, 2004). Each year approximately 100 firefighters lose their lives and thousands are injured while performing their duties in fire suppression and emergency medical services (NFPA, 2004).

An individual preparing for a career in the fire service must be prepared academically to meet the knowledge requirements to be a safe and effective firefighter, as well as physically, to meet the strenuous physical demands of firefighting. These physical demands manifest themselves during the application process, recruit training, and during a career that can span twenty-five years or more.

Research has shown the need for high levels of fitness to perform safely in the fire service (IAFF/IAFC, 1999). Strength is required to perform victim rescue, place ladders,

handle hose lines, and force entry with heavy tools (Hall & Adams, 1998). Aerobic and anaerobic endurance is needed to move rapidly down hallways, climb ladders, and combat fires.

Recent developments in the fire service have created renewed interest in fire fighter fitness. Many departments have or are implementing a fitness program. The fire service has recognized that fitness is one way of reducing the number of injuries that occur in the fire service at an alarming rate. A firefighter that possesses the level of fitness required by fire fighting is safer, more productive, easier to train and cheaper.

What the best way to determine the physical ability of an individual to perform the duties required of a firefighter is a subject that needs to be determined. One recognized method to determine the fitness of a fire fighter is to use a test that simulates the physical and mechanical demands of fire fighting. These tests have been referred to as physical ability tests, physical agility tests, and combat tests (IAFF/IAFC, 1999). Another recognized method to determine an individual's fitness to participate in the occupation of fire fighter is through the use of a fitness evaluation, using standard physical fitness tests (Davis & Dotson, 1992).

The fire service uses many different physical ability tests to determine the fitness level of applicants as well as incumbent firefighters. Although each is different they are all similar in that they test the individual's muscular strength, muscular endurance, and aerobic capacity.

The fire service also uses fitness evaluations to determine and assess the fitness and performance abilities of a firefighter. While fitness evaluations are widely used at health and fitness clubs, they have been slower to catch on in the fire service. In recent

years fitness evaluations have become a required element in fire service wellness programs. Common elements of fitness evaluations include aerobic capacity, muscular strength, muscular endurance and body composition tests. Some programs also include a flexibility assessment. Fitness evaluations are used for both fire recruits and incumbent firefighters.

This study's goal was to identify a research tool to evaluate MATC Fire Science student's physical ability for the fire service, apply it, and determine the need for a fitness component in its curriculum.

The organization and contents of the chapter include:

- Method of fitness evaluation chosen for this project and reasons for its choice
- Research design
- Population evaluated
- Data collection methods
- Instrumentation

Methodology Chosen

After reviewing the different methods of fitness evaluation used in the fire service the researcher chose *Professional Firefighter Profiles* as the fitness evaluation tool to be used for this study.

Physical ability tests were not chosen because of the specialized equipment required, number of personnel required to administer the test, and the time required to test approximately 50 subjects (estimated to be 10 to 12 hours). Consideration was given to having the test performed at a certified CPAT testing site but, logistics and cost per subject of $100.00 were prohibitive.

Professional Firefighter Profiles (Berry & Matic, 1998) was chosen because it met the following test criteria listed both in it and *Essentials of Strength Training and Conditioning* (Semenick, 2004):

- Safe: the evaluation uses many sub-maximal tests thereby reducing the stress placed on subjects.
- Job Related: *Professional Firefighter Profiles* was developed for the fire service.
- Inexpensive: the equipment required was readily available and use of the program was granted by the author.
- Brief: estimated time to complete the evaluation fit into a two hour time slot.
- Easy to Administer: the evaluation could be easily administered by the researcher because of his familiarity with its procedures.
- Valid: data found in the study tool applies to new firefighters, the position to which study subjects aspire.
- Reliable: *Professional Firefighter Profiles* has been in use since 1992, longer than most other evaluation methods studied.
- Objective: data obtained is quantitative.

Research Design

The research employed a quantitative fitness evaluation. Participating subject's fitness was evaluated using the *Professional Firefighters Profile Physical Ability Evaluation* (Appendix C). The following information was obtained for each subject employing the physical ability evaluation worksheet (Appendix B) and *profile* sheet (Appendix D):

- Height in inches
- Weight in pounds
- Lean body mass
- Physical Size Profile using the above values
- Bench press maximum estimate using a sub-maximal repetition test
- Lat pull maximum estimate using a sub-maximal repetition test
- Grip strength using a hand grip dynamometer
- Strength profile using the above values
- Aerobic capacity in Mets using a 5-minute box step test
- Muscular endurance using a one minute sit-up test
- Body composition (percent body fat) using an one site skin fold
- Fitness Profile using the above results
- Fire Power Index

A comparative analysis was then performed comparing the results of the study to the data found in *Professional Firefighter Profiles* (Appendix C). Mean, median, range and standard deviation were analyzed to compare the physical abilities of the subjects to those of successful fire recruits to determine the need for a fitness component in the Fire Science Curriculum at Milwaukee Area Technical College.

Population

The study population included all second year students enrolled in the Fire Science Curriculum at MATC. Second year students were chosen because they will be applying their physical abilities in the fire service within the next year when they finish their studies at MATC. To facilitate this study students enrolled in the course Fire

Department Health and Safety were asked to participate in the study. Participation was voluntary. Forty seven out of fifty subjects enrolled in the course participated in the study. This was approximately 90% of the total number of second year students enrolled.

All subjects signed an approved consent form to participate in the study and allow the use of their data (Appendix A). As a benefit to each subject, they received a completed *Professional Firefighter Profile* using their individual data to objectively view their physical abilities and compare them to successful fire fighters that have gained employment. Subjects were also given a Profile Summary of all participants in this study (Appendix D).

Data Collection

Subjects were evaluated using the testing methods outlined in *Professional Firefighter Profiles* (Appendix C). Every effort was made to follow the procedures outlined. All scores were calculated using the methods and tables included. Mean, median, range and standard deviation were calculated for all values, test results and profiles (Figure 4-1). These values for study subjects (N=47) were then compared to those found for entry level firefighters (N=337) found in Appendix C.

Instrumentation

Data gathered from this study centered on evaluating the fitness for firefighting of fire science students enrolled at Milwaukee Area Technical College. Data came from subjects that are MATC students only, therefore results apply only to MATC and its students. Data was used to determine the need for a fitness component in the Fire Science Curriculum at Milwaukee Area Technical College. Collection of data came from fitness evaluations employing *Professional Firefighter Profiles* only.

Summary

Firefighting is a physically demanding and dangerous occupation. The Fire Science Curriculum at Milwaukee Area Technical College does not have a physical fitness component. This study determined which fitness evaluation tool could best be applied to its subjects, MATC students, to determine the need for a fitness component in the curriculum. This was accomplished using *Professional Firefighter Profiles* to quantitatively evaluate the physical abilities of second year MATC students that participated in the study and comparing the results to the known abilities of successful fire recruits.

Chapter 4: Findings and Analysis

Introduction

The mission of the Milwaukee Area Technical College Fire Science program is to prepare students for a career in the fire service, and to meet the needs of the communities MATC serves. The primary responsibility of the instructional staff is the delivery of effective education that meets the needs of the students, community and fire service.

While the Fire Science Curriculum does a great job educating its students academically, little emphasis is placed on preparing them physically for a career in the fire service. A method of determining the need for a fitness component in the Milwaukee Area Technical College curriculum needs to be determined and applied to provide for the safety of our students as they enter their chosen field.

Firefighting is one of the nations most dangerous and hazardous jobs with heart attacks, high physical stress levels, and injury all too common (USFA, 2004). Each year approximately 100 firefighters lose their lives and thousands are injured while performing their duties in fire suppression and emergency medical services (NFPA, 2004).

An individual preparing for a career in the fire service must be prepared academically to meet the knowledge requirements to be a safe and effective firefighter, as well as physically, to meet the strenuous physical demands of firefighting. These physical demands manifest themselves during the application process, recruit training, and during a career that can span twenty-five years or more.

Research has shown the need for high levels of fitness to perform safely in the fire service (IAFF/IAFC, 1999). Strength is required to perform victim rescue, place ladders,

handle hose lines, and force entry with heavy tools (Hall and Adams, 1998). Aerobic and anaerobic endurance is needed to move rapidly down hallways, climb ladders, and combat fires.

Recent developments in the fire service have created renewed interest in fire fighter fitness. Many departments have or are implementing a fitness program. The fire service has recognized that fitness is one way of reducing the number of injuries that occur in the fire service. A firefighter that possesses the level of fitness required by fire fighting is safer, more productive, easier to train and less costly to retain.

What the best way to determine the physical ability of an individual to perform the duties required of a firefighter is a subject needed to be determined. One recognized method to determine the fitness of a firefighter is to use a test that simulates the physical and mechanical demands of firefighting. These tests have been referred to as physical ability tests, physical agility tests, and combat tests (IAFF/IAFC, 1999). Another recognized method to determine an individual's fitness to participate in the occupation of firefighter is through the use of a fitness evaluation, using standard physical fitness tests (Davis and Dotson, 1992).

The fire service uses many different physical ability tests to determine the fitness level of applicants as well as incumbent firefighters. Although each is different they are all similar in that they test the individual's muscular strength, muscular endurance, and aerobic capacity.

The fire service also uses fitness evaluations to determine and assess the fitness and performance abilities of a firefighter. While fitness evaluations are widely used at health and fitness clubs, they have been slower to catch on in the fire service. In recent

years fitness evaluations have become a required element in fire service wellness programs. Common elements of fitness evaluations include aerobic capacity, muscular strength, muscular endurance and body composition tests. Some programs also include a flexibility assessment. Fitness evaluations are used for both fire recruits and incumbent firefighters.

This study determined which fitness evaluation tool could best be applied to its subjects, MATC fire science students, to determine the need for a fitness component in the curriculum. This was accomplished using *Professional Firefighter Profiles* to quantitatively and qualitatively evaluate the physical abilities of second year MATC students that participated in the study and, comparing the results to the known abilities of successful fire recruits.

Results of the Research

Research was conducted using methodology outlined in P*rofessional Firefighter Profiles.* Every effort was made to simulate test methodology described. Subject number was 47. Descriptive statistics were used to summarize and analyze the results obtained using mean, median, range (maximum and minimum), and standard deviation. All test variables, profile scores, and Fire Power Index scores were summarized in Table 4-1.

Table 4-1: Summary of Descriptive Statistics used to analyze *Professional Firefighter Profiles Physical Abilities Evaluation* N=47

Variable	Mean	Median	Maximum	Minimum	Standard Deviation
Age	20.9	20.0	28.0	18.0	2.27
Height	70.5	71.0	74.0	63.0	2.31
Weight	182.0	178.0	259.0	135.0	24.3
Lean Body Mass	153.0	154.0	205.0	95.8	19.2
Size Profile	51.3	52.0	79.0	13.0	11.9
Bench Press	196.0	193	322.0	93.0	55.1
Lat Pull	186.0	185	295.0	80.0	39.4
Hand Grip	135.0	134	190.0	76.0	19.0
Strength Profile	50.3	48	78.0	15.3	12.3
Max VO2-Met's	12.4	12.2	18.0	9.1	1.83
Sit-Ups	37.1	37.0	54.0	19	8.7
Body Fat %	15.3	12.5	31.9	3.9	7.38
Fitness Profile	51.3	51.0	82.0	11.0	13.7
Fire Power Index	510.0	515.0	698.0	244.0	85.1

Individual test results were evaluated based on percentile norms found on the profile sheets (Appendix C) developed for each subject. All low scores for individual test variables were noted and summarized in Table 4-2 and 4-3.

Table 4-2: Number of test variables receiving a low score. Profile and Index scores not included.

Number of Variables Scored Low	Number of Subjects	Percent of Total subjects N=47
1	15	31.9%
2	10	21.2%
3	2	4.2%
4 or more	2	4.2%
Total	29	61.7%

Table 4-2 shows that nearly two thirds of the test subjects had at least one test deficiency. Two subjects were actually deficient in six test categories as well as all profiles and the Index Score.

Table 4-3: Analysis of individual variables which exhibit a low score based on Profile percentile norms.

Variable	# Subjects with Low Scores	Percent Total Subjects N=47
Age	1	2.1%
Height	2	4.2%
Weight	3	6.3%
L.B.M.	5	10.6%
Size Profile	3	4.2%
Bench Press	2	4.2%
Lat Pull	6	12.7%
Hand Grip	1	2.1%
Strength Profile	5	10.6%
Max VO2-MET's	2	4.2%
Sit-Ups	20	42.5%
Body Fat %	4	8.5%
Fitness Profile	6	12.7%
Fire Power Index	2	4.2%

It is interesting to note that a low test variable score did not necessarily mean a poor evaluation. The three test subjects with the highest Fire Power Index scores had at least one score that fell into the low category.

Mean scores of subjects tested in the study were also compared to mean scores of 337 incumbent firefighter's period one scores found in *Professional Firefighter Profiles.* Incumbent scores are period one scores from the beginning of their training period. Differences were calculated and summarized in Table 4-4.

Table 4-4: Summary of differences between study mean test variable scores (N=47) to mean variable scores of successful fire recruit period one scores (N=337).

Variable	Number of Test Subjects with Scores < Incumbents Mean	Difference Between Mean Scores	Percent of Incumbent Mean
Age	45	-5.2	-19%
Height	17	-0.3	-0.4%
Weight	27	-5.47	-3.1%
L.B.M.	26	-8.9	-5.4%
Bench Press	32	-21.8	-10.0%
Lat Pull	40	-48.4	-20.6%
Hand Grip	21	+2.9	+1.5%
Max VO2-MET's	19	+0.11	+0.09%
Sit-Ups	40	-9.3	-20.6%
Body Fat %	17	+1.9	+14.0%
Size Profile	28	-4.4	-7.8%
Strength Profile	36	-9.1	-15.3%
Fitness Profile	41	-9.7	-15.9%
Fire Power Index	29	-77.4	-13.1%

As can be seen in Table 4-4, test subject scores were lower than successful recruit scores in all categories except hand grip and Max VO2. It should be noted that although body fat % shows a positive difference, it is actually a negative result, as an increase in percent body fat is undesirable when evaluating fitness. Although age shows a negative value, it is not significant as a study variable as far as evaluating is concerned. Several of the tests conducted (body fat, Max VO2, lean body mass) actually penalize test subjects as their age increases.

A significant negative difference is found in the test variables assessing muscular strength (bench press, lat pull) and muscular endurance (sit-ups) as well as body fat (14%) and all profile and the Fire Power Index scores. Test subjects do not compare favorably to the data group physically.

Summary

The *Professional Firefighter Profile Physical Ability Evaluation* was administered to 47 second year Milwaukee Area Technical College Fire Science students. Test results were analyzed using descriptive statistics for mean, median, range and standard deviation (Figure-1). Individual variable results were also compared to percentile norms found in the evaluation and scores identified as low were documented (Tables 4-2 and 4-3). Mean study scores for each variable were also compared to mean period one test scores for 337 successful fire recruits.

Analysis of the results showed that 61.7 % of test subjects had at least one score rated low by the profile. A significant number of test subjects scored low in the sit-up, lat pull, lean body mass tests as well as the strength and fitness profiles. When mean test results were compared to mean period one scores of 337 successful fire recruits, test

subjects scored lower in 11 of 13 test categories. Especially significant deficiencies were noted in the bench press, lat pull, lean body mass, sit-ups, and body fat test results. Significant shortcomings were also found in the strength, fitness profiles and Fire Power Index.

Chapter 5: Discussion

Introduction

The mission of the Milwaukee Area Technical College Fire Science program is to prepare students for a career in the fire service, and to meet the needs of the communities MATC serves. The primary responsibility of the instructional staff is the delivery of effective education that meets the needs of the students, community and fire service. (MATC, 2005).

An individual preparing for a career in the fire service must be prepared academically to meet the knowledge requirements to be a safe and effective firefighter, as well as physically, to meet the strenuous physical demands of firefighting. These physical demands manifest themselves during the application process, recruit training, and during a career that can span twenty-five years or more.

Research has shown the need for high levels of fitness to perform safely in the fire service (IAFF/IAFC, 1999). Strength is required to perform victim rescue, place ladders, handle hose lines, and force entry with heavy tools (Hall and Adams, 1998). Aerobic and anaerobic endurance is needed to move rapidly down hallways, climb ladders, and combat fires.

Recent developments in the fire service have created renewed interest in fire fighter fitness. Many departments have or are implementing a fitness program. The fire service has recognized that fitness is one way of reducing the number of injuries that occur in the fire service. A firefighter that possesses the level of fitness required by fire fighting is safer, more productive, easier to train and less costly to retain.

What the best way to determine the physical ability of an individual to perform the duties required of a firefighter is a subject needed to be determined. One recognized method to determine the fitness of a firefighter is to use a test that simulates the physical and mechanical demands of firefighting. These tests have been referred to as physical ability tests, physical agility tests, and combat tests (IAFF/IAFC, 1999). Another recognized method to determine an individual's fitness to participate in the occupation of firefighter is through the use of a fitness evaluation, using standard physical fitness tests (Davis and Dotson, 1992).

This study determined which fitness evaluation tool could best be applied to its subjects, MATC fire science students, to determine the need for a fitness component in the curriculum. This was accomplished using *Professional Firefighter Profiles* to quantitatively and qualitatively evaluate the physical abilities of second year MATC students that participated in the study and, comparing the results to the known abilities of successful fire recruits.

Statement of the Problem

The Fire Science Curriculum at Milwaukee Area Technical College meets the standards set forth by the National Fire Administration and the State of Wisconsin. It provides an exceptional education in the diverse fields of knowledge required for success in a career as a firefighter. The knowledge gained by the students provides them with a strong academic foundation in fire service practices and theory.

Firefighting is one of the nations most dangerous and hazardous jobs with heart attacks, high physical stress levels, and injury all common occurrences (USFA, 2004). Each year approximately 100 firefighters lose their lives and thousands are injured while

performing their duties in fire suppression and emergency medical services (NFPA, 2004).

While the Fire Science Curriculum does a great job educating its students academically, little emphasis is placed on preparing them physically for a career in the fire service. A method of determining the need for a fitness component in the Milwaukee Area Technical College curriculum needs to be determined and applied to provide for the safety of our students as they enter their chosen field.

Summary of Study Procedures

The study population included all second year students enrolled in the Fire Science Curriculum at MATC. Second year students were chosen because they will be applying their physical abilities in the fire service within the next year, when they finish their studies at MATC. To facilitate this study students enrolled in the course Fire Department Health and Safety were asked to participate in the study. Participation was voluntary. Forty seven out of fifty subjects enrolled in the course participated in the study. This was approximately 90% of the total number of second year students enrolled. All subjects signed an approved consent form to participate in the study and allow the use of their data (Appendix A). As a benefit to each subject, they received a completed *Professional Firefighter Profile* using their individual data to objectively view their physical abilities and compare them to successful fire fighters that have gained employment. Subjects were also given a Profile Summary of all participants in this study (Appendix C).

After reviewing the different methods of fitness evaluation used in the fire service the researcher chose *Professional Firefighter Profiles* as the fitness evaluation tool to be

used for this study. Every effort was made to follow the procedures outlined. All scores were calculated using the methods and tables included.

The following information was obtained for each subject employing the physical ability evaluation worksheet (Appendix B) and *Profile* sheet (Appendix C):

- Height in inches
- Weight in pounds
- Lean body mass
- Physical Size Profile using the above values
- Bench press maximum estimate using a sub-maximal repetition test
- Lat pull maximum estimate using a sub-maximal repetition test
- Grip strength using a hand grip dynamometer
- Strength profile using the above values
- Aerobic capacity in Mets using a 5-minute box step test
- Muscular endurance using a one minute sit-up test
- Body composition (percent body fat) using a one site skin fold
- Fitness Profile using the above results
- Fire Power Index

A comparative analysis was then performed comparing the results of the study to the data found in *Professional Firefighter Profiles*. Test results were analyzed using descriptive statistics for mean, median, range and standard deviation (Figure 4-1). Individual variable results were also compared to percentile norms found in the evaluation and scores identified as low were documented (Tables 4-2 and 4-3). Mean

study scores for each variable were also compared to mean period one test scores for 337 successful fire recruits (Table 4-4).

Analysis of the results showed that 61.7% of test subjects had at least one score rated low by the profile. A significant number of test subjects scored low in the sit-up, lat pull, lean body mass tests as well as the strength and fitness profiles. When mean test results were compared to mean period one scores of 337 successful fire recruits, test subjects scored lower in 11 of 13 test categories. Especially significant deficiencies were noted in the bench press, lat pull, lean body mass, sit-ups, and body fat test results. Significant shortcomings were also found in the strength, fitness profiles and Fire Power Index.

As a benefit to each subject, they received a completed *Professional Firefighter Profile* using their individual data to objectively view their physical abilities and compare them to successful fire fighters that have gained employment. Subjects were also given a Profile Summary of all participants in this study (Appendix C).

Conclusions and Implications

The importance of fitness to a firefighter has been well documented in Chapters One and Two of this paper. After reviewing and analyzing the results of this study, the following conclusions were evident.

The 47 Fire Science students evaluated using Professional Firefighter Profiles mean test results and profile scores compared favorably with the percentile norms for professional firefighters found within. The majority of mean scores were found to be within the normal and average range (Appendix C). However, further analysis of individual scores and results found that 61.7% of the subjects scored low in one or more

individual tests. Low scores were found in six or more subjects for muscular endurance, muscular strength and body composition. This indicates that a majority of fire science students ready to enter the fire service have a physical deficiency that might have a negative impact on their employability. This could be addressed by a fitness component.

Studies have shown that an individual's physical abilities begin to decline after the age of approximately 25 unless exercise is performed (Holloway, 1994). Therefore, even an individual that tested average or above in each category could fall below this benchmark at some point in their twenty five plus year career if they do not participate in some type of exercise program. This could create an unsafe situation for the firefighter, his/her fellow workers, and the community they have been hired to protect. Providing education in fitness would be a skill MATC students could use to prevent this.

When compared to test results of 337 successful fire recruits of a large metropolitan Fire Department, the results were even more revealing. At least 17 (36.1 %) and not more than 40 (85.1 %) of the subjects had mean scores lower than those who had successfully completed recruit training in each category. Significant differences were found in all categories, especially in muscular endurance, strength, and the fitness profile demonstrating that a fitness component in their training could be beneficial to them for success in recruit training.

One can see from the range data and standard deviations that the population studied was more homogenous than the subjects whose data they were compared to. Test subjects ranged in age from only 18 to 28, while the successful fire recruits were 18 to 45 years of age. This is especially significant in that most of the study subjects were at their physical peak (under 25) while more than half of the successful fire recruits were older

(mean age 26). When looking at how results are calculated, individuals older than 25 are penalized in several of the tests for this reason. This indicates that fire science students studied compare even less favorably with the successful fire recruits.

Providing a fitness component in the Milwaukee Area Technical College Fire Science Program would be of tremendous value to its students. It would identify and address physical deficiencies that could have a negative impact in the following aspects of a student's career in the fire service.

- It would assist the student in passing the physical ability test the potential employer uses during the hiring process.
- Preparing a student physically would give them a greater chance of success during the recruit training part of their career, insuring that they have prepared physically as well as mentally for its rigors.
- Firefighting is a dangerous occupation. Fitness is required for the firefighter to operate safely and effectively during a career that can exceed 25 years. Fitness training at MATC could provide the life long skill required to achieve this goal.
- Fitness and health are related. A fit firefighter is one that can retire fit and healthy, enjoying this part of their career.

Recommendations

It is obvious that most if not all Milwaukee Area Technical College Fire Science students could benefit from a fitness component if it were included in the program. This fitness component should address the fitness needs of a firefighter throughout his/her career. In order to accomplish this, the following should be included:

- All students should participate in the Candidate Physical Ability Test (CPAT). This would include an orientation, practice, and the test itself. This could be accomplished in a joint venture between MATC and the West Allis Fire Department, as they are the only recognized CPAT Testing Site in our district. Participating in the CPAT would provide the students that passed with a certificate of completion which can be used in some hiring situations. Those who fail, would not do so in a hiring situation, and could address deficiencies that the CPAT reveals, address them through training, and pass the CPAT in the future.
- All students should participate in the Professional Firefighter Evaluation at the beginning of the semester. Each student would receive an objective evaluation of their physical abilities and how they compare to those required in firefighting. In addition, they could compare themselves to those who have already completed training for a fire department, as well as other fire science students that have come before them.
- Students should be provided with education in the basic principles of fitness and their application. This would provide them with the life skill to develop an exercise program for the fire service which they could apply during their careers.
- Students should develop "Fitness Action Plans "with the assistance of their instructors, based on the results of their fitness evaluations. These action plans could address any physical deficiencies discovered and strive for improvement in all areas and allow application of the principles learned as outlined above.

- Nutritional guidance should also be included to provide support for the fitness plan and also for those students that need assistance with the body composition portion of fitness.
- Students should re-evaluate their fitness at the end of the class to compare their ability after implementing their action plan to see if it has been effective and to make changes as needed.

The perfect place for this fitness component would be in a new class that is being developed, "Firefighter Employability". This class is being developed to assist the student in the application process for the fire service. Since fitness is a big part of the hiring process, it is only natural that it be included here. Incorporating a fitness component that addresses the material described would provide fitness support for MATC Fire Science students throughout their careers and beyond.

Recommendations for Future Research

An interesting future study would be to compare the physical abilities of a potential firefighter using a fitness evaluation, and then compare those results to success in the Candidate Physical Ability Test. This could identify which component(s) of fitness, (strength, muscular endurance, aerobic capacity, body composition) have the most significance impact on its successful completion. This could then be used to develop a training program specifically for the students taking the CPAT. This could be done with data from the Firefighter Employability class if it incorporates all the suggested components listed in the previous section.

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Appendix A

Copy of Consent Form

Consent to Participate In UW-Stout Approved Research

Title: Determining the Need for an Expanded Fitness Component in the Fire Science Program at Milwaukee Area Technical College

Investigator: Tornislav L. Matic
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Research Sponsor: Joseph Benkowski
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Description: The study will consist of a fitness evaluation that will test subjects in the following areas and ways to obtain a size, strength, fitness, and firefighter profile:

1. Size
   - Height measured in inches
   - Weight measured in pounds
   - Lean body mass using a one site skin fold measure with a body fat caliper
2. Strength
   - Bench press max estimate using a repetition maximum of between 8-25 repetitions
   - Lat pull max estimate using a repletion maximum between 8-25 repetitions
   - Hand grip strength using a hand grip dynamometer
3. Fitness
   - Aerobic capacity using the five minute box step test
   - Muscular endurance using a one minute sit-up test
   - Body fat estimate using the one site skin fold with a caliper

All of these tests are sub-maximal tests to eliminate the chance of discomfort to the test subjects. Scores are achieved using the Professional Firefighter Profile format to determine a size, strength, fitness score as well as an overall Firefighter Profile. These scores can be compared to percentile norms as well as to the data from a study done by the Milwaukee Fire Department, the largest fire department in MATC's district and its number one employer of graduates.

Risks and Benefits: The procedure used will be one that has been used for 15 years at a large metropolitan fire department. All tests performed are performed at sub-maximal levels to prevent discomfort and minimize the chance of injury. In addition, the testing sequence is designed to flow so that one test prepares the subject for the next. Tests without a physical component are performed first (weight, height, body composition), followed by the step test and sit-up test to raise core temperature to warm-up the body. Strength tests follow this warm-up and also include a warm-up phase when necessary. This is done to gain the best result and to eliminate any possible discomfort.

The benefits subjects will receive are an objective evaluation of their physical abilities as a firefighter and will the ability to compare themselves to firefighters that have successfully gained employment with a large metropolitan fire department. In addition

the subjects receive guidance on how to improve their abilities (class discussion), something that can **benefit** them in the long term.

Time Commitment and Payment: Time commitment will be minimal as the test is an actual portion of the course curriculum. There will be no payment for participation.

Confidentiality: Your name will not be included on any documents. We do not believe that you can be identified from any of this information. This informed consent will not be kept with any of the other documents completed with this project"

Right to Withdraw: "Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you. Should you choose to participate and later wish to withdraw from the study, you may discontinue your participation at this time without incurring adverse consequences."

IRB Approval: This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator.

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Advisor:
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Statement of Consent:
By signing this consent form you agree to participate in the project entitled, **Determining the Need for an Expanded Fitness Component in the Fire Science Program at Milwaukee Area Technical College.**
Tomislav L. Matic, researcher.

_____
Signature..... Date

_____
Signature of parent or guardian:..... Date
(If minors are involved)

Appendix B

Copy of Professional Firefighter Profiles Physical Ability Evaluation Work Sheet

Professional Firefighter Profiles TM
Physical Ability Evaluation Work Sheet

Name:_____ Test Period: 1 2 3 15 month Date:____/____/____

Age:_____ Gender: M / F Skinfold:_____

SIZE PROFILE

HEIGHT.....inches_____

WEIGHT.....lbs._____

LEAN WEIGHT ESTIMATES.....lbs._____

STRENGTH PROFILE

BENCH PRESS: Test Weight_____ Reps_____1-RM Est._____

LAT PULLDOWN: Test Weight_____ Reps_____1-RM Est._____

HAND GRIP: 1st Attempt_____ 2nd Attempt_____Best Attempt_____

FITNESS PROFILE

STEP TEST: 15s pulse____ Initial_____ Age Adj._____/ 3.5 = MET's_____
(Adjunct data base value: Age Table x BW-KG /1,000 = Liter/mm._____)

SIT-UPS:.....total reps_____

BODY FAT ESTIMATE..... percent_____

Size Score:_____ + Strength Score_____ + Fitness Score_____ / 0.3 = FIREPOWER INDEX™_____

Appendix C

Copy of Professional Firefighter Profiles Physical Ability Evaluation Summary