CHAPTER 2

REVIEW OF LITERATURE AND RELATED RESEARCH

The purpose of this study was to determine the characteristics of the turfgrass industry in the year 2020 in order to make recommendations for curriculum content for turfgrass course work in agricultural education programs. This chapter provides a review of literature and related research concerning the future of the turfgrass industry, curriculum development, futures research, and the Delphi technique.

A computerized search of several data bases was made in a review of the literature for this study. These included Educational Resources Information Center (ERIC), BIOSIS, Current Contents Plus, Expanded Academic Index, Agricola, and the Turfgrass Information File (TGIF). The ERIC data base included materials listed in Research in Education (RIE) and the Current Index to Journals in Education (CIJE). The TGIF data base at Michigan State University contains over 71,000 records.

A comprehensive manual search was conducted of several non-indexed trade magazines and journals that were related specifically to the turfgrass industry. The Guide to Current Periodicals was searched to locate publications addressing turfgrass and the turfgrass industry, as well as futuring and educational research topics.

The purpose of the manual and computerized searches was to locate documents that contained one or more of the following descriptors: "Curriculum," "Curriculum Planning," "Trends and Issues," "Futures," "Futuring," "Futurism," "Vocational Education," "Vocational Agriculture," "Turfgrass," "Delphi," and "Delphi Technique."

Agricultural Education

In an effort to improve both agriculture and education, the Morrill Act of 1862 was passed establishing the Land Grant Colleges (Gordon, 1999; Herren, 1989). Afterwards, public sentiment grew in the direction of vocational education as expressed by businessmen, labor leaders, and rural Americans. "By 1917, the people of the nation realized that the teaching of agricultural courses in the public schools was effective and desired to promote the idea" (James & Porter, 1962, p. 2). Such efforts resulted in the passage of the Smith-Hughes Act in 1917 with the main thrust "to train present and prospective farmers for proficiency in farming" (Calhoun & Finch, 1982, p. 188).

The umbrella of agriculture changed drastically through several decades. Technology increased farm production, thus reducing the number of small farms. As the number of farms continued to decrease, so did the number of people on the farms. This trend encouraged the government to revisit vocational agriculture and enlarge its legislative scope. Therefore, the Vocational Education Act of 1963 (Public Law 88-210) was passed by Congress with the focus of strengthening and improving vocational education, and expanding into areas not originally authorized (Phipps, 1980). Such expansion trained workers for new and emerging occupations which included forestry, horticulture, natural resources, and agribusiness (Flanders, 1988). In addition, the modern understanding of and appreciation for agriculture and agriculturally-related programs has encouraged administrators of public schools and vocational-technical schools to plan in the establishment of programs beyond traditional agriculture (Stevens, 1966).

Horticulture and agronomy became components of these expanded areas, with turfgrass being classified in either or both. Turfgrass courses have been a part of agricultural education programs since the 1980's. Currently, as a result of the Vocational

Education Act of 1963, turfgrass is an official, integral part of many agricultural education programs. The FFA horticultural contest (including turfgrass) is one of the nine national contests conducted by the National FFA Organization (National FFA Contests, 1996).

Turfgrass Discipline

A search of the literature revealed no information about futures research in developing curriculum content or turfgrass programs in agricultural education, but information was found describing the industry and students entering it.

Introduction

The management of turfgrass is a discipline that requires all managers to become problem solvers in the agronomic, horticultural and pest management areas, as well as human resource management, communications, and financial resources (Jaques, 1998; Fry, Thien, Miller, Elsea, & Kraus, 1998; Wake, 1999b; Ellis, 1999, Grigg, 1999). Most funding from both private and public sources to support research in turfgrass is targeted at golf courses. Therefore, golf course managers become the "torchbearers" for the entire turfgrass industry, reaping these initial benefits of research and findings. Ultimately, these findings are further tested for sod production, commercial lawn care, sports field management, and utility turf maintenance applications, with appropriate information being disseminated in time.

Employers expect turfgrass graduates to be qualified agronomists, effective communicators, financial planners, team leaders, and environmental stewards (Wake, 1999a; Jaques, 1998; Page, 1999; Ellis, 1999; Williams, 1999; Fry, et. al., 1998). Ellis further stated that training and continuing education were the most attractive employee benefits, and that superintendents would be tested on technical agronomy, attitude, and personality traits. Wagner (1999) indicated that the future curriculum of turfgrass students involved learning the traditional plant and soil science classes, as well as communications, business management, and hospitality courses. Grigg (1999) suggested that the greatest challenge confronting the modern golf course superintendent is working with and managing people.

Dysart (1995) indicated that the 1980's may be characterized as the decade when environmentalists often confronted golf course superintendents with almost a religious fervor. However, Dysart further stated "the 1990's was a period when increasingly progressive superintendents wound up showing the environmentalists a thing or two." One endpoint of a superintendent's migration to more environmental awareness is the application of such programs as the Audubon Cooperative Sanctuary Program for Golf Courses under the direction of the Audubon Society of New York (Dysart; Jaques, 1998, Bishop, 1997; Dodson, 2001). The best public relation a golf course can receive is certification as a cooperative sanctuary (Dysart). Peacock and Bowman (1999) reported that the need to "do something" about the environment may result in regulations that actually fail to protect threatened ecosystems. Thus, research can help regulators develop effective rules for golf courses.

Management Packages

"Best management practice" packages including an "integrated pest management" program will be the written plan of superintendents' current or future management practices, such as pesticides, fertilizers, soil amendments, etc. (McCarty, 2001; McCarty, 1995; Clark, 1997; Kopec, 1997; Danneberger, 1997; Voigt, 1998). Some of the environmental concerns being faced, such as the effects of fertilizer and pesticide use on water quality, could have significant impact on the game of golf, the management of golf courses, and the profession of the golf course manager (Riordan & Busey, 1993). Horvath and Vargas (2000) revealed that research was the key to the effective and successful use of biological control against turfgrass pests. These factors have not been overlooked by the research community and industry; universities and private golf-related foundations have set priorities to address these and other potential future problems.

The first step in integrated pest management is correct identification of the pest, whether it be an insect, weed, disease, etc. The NEPER-Weed program, a picture-based expert system in weed identification, is the most user-friendly program, even to novices (Schulthess, Schroeder, Kamel, AbdElGhani, Hassanein, AbdElHady, AbdElShafi, Ritchie, Ward, & Sticklen, 1996). A superintendent can detect insect pests and weed problems using a cellular Global Positioning System (GPS) receiver (Perrault, 1998).

The future will bring changes in the turf industry. Environmental regulations at the international, federal, state, and local levels will result in close scrutiny of pesticide, fertilizer, and irrigation applications (Duncan & Carrow, 2000; Walter, 1996; Borchardt, 1999; Peacock & Bowman, 1999).

Expanding Technology through Genetics

Molecular biology is a large field of science that is giving rise to many new methods and applications. This technology is applicable to a wide range of plant species, including turfgrasses (Callahan, Caetano-Anolles, Bassam, Weaver, MacKenzie, & Gresshoff, 1993). Genetic fingerprinting involves the use of DNA (deoxyribonucleic acid) to identify and distinguish individual organisms (Dyer & Littlepage, 2000). Genetic (DNA) fingerprinting of turfgrass plants can be used for diagnosing insect and disease problems, identifying and creating new cultivars, protecting proprietary rights, reducing product contamination by separating weed species and subspecies, and introducing herbicide resistance. (Dyer & Littlepage; Callahan et al., 1993; Nus, 1993).

Diesburg (1997) indicated that the perfect turfgrass would grow to a pre-determined height, never need mowing, have no pest problems, and stay uniformly green throughout all types of stress. Development of such a fantasy grass may be possible through gene splicing (Diesburg; Nus, 1993). New technology and continued research will bring improvements to turfgrass species grown on golf courses.

Water Quality

To address water quality and quantity issues, programs have been initiated at several universities to develop species and cultivars that require less irrigation and energy for maintenance (Gibeault & Meyer, 1989; Hook, Hanna, & Maw, 1993). Mintenko and Smith (1999) reported that undomesticated native grass species may someday produce turfgrass cultivars that thrive with reduced maintenance. Duncan (1998) reported that seashore paspalum offers many benefits on golf courses, particularly in situations where other grasses might be environmentally incompatible, prone to costly maintenance needs, or susceptible to stress. Duncan and Carrow (2000) further reported that seashore paspalum offers many environmentally-friendly characteristics that will be demanded in future turfgrasses. Duncan (1997) reported that developing low-input, cosmetically-appealing turf for use on golf courses and taking little from the environment would be the route of the future. Industry cannot be satisfied with today's turfgrass cultivars, as good as they may be (Diesburg, 1997).

Ponds require monitoring and careful attention to avoid severe decline in water quality (Ennis & Bilawa, 2000). Using reclaimed water (treated wastewater) for irrigation alleviates demand on scarce potable water resources and on groundwater supplies (King, Balogh, & Harmel, 2000; Borchardt, 1999). Borchardt further stated that many golf courses are using reclaimed water to preserve community resources and practice environmental stewardship. Golf courses potentially affect water resources, but a sound management plan can help avoid water pollution (Harrison, 1998). Golf courses must use water to survive, but careful plant selection can help reduce irrigation needs (Smith, 1998). Therefore, the conservation of water through applying xeriscape (wise use of water through selecting drought-tolerant species) practices is possible.

As more golf courses are built and existing ones expand, water availability, quality, and use issues loom ever larger on the industry's horizon (Hawes, 1999). Thus, water shortages and rationing caused by regional droughts further impact the "think tank" of the superintendent. Underground barriers installed under golf greens can prevent leaching of turf chemicals, thus eliminating groundwater contamination and allowing greater efficiency in the recycling of water (Torello, Li, & Xing, 1999).

New Cultivars

Many seeded turfgrasses are constantly being tested and evaluated for improved characteristics (Shearman, 1996). Seeded bermudagrasses are becoming more common in research plots and on golf courses (Baltensperger & Taliaferro, 1998). Huff (1998) reported that researchers hope to develop more annual bluegrass cultivars for golf courses. Hanna (1998) reported that irradiated mutations, crossbred hybrids, and genetically-engineered bermudagrasses may offer superior tolerance to heat, drought, insects, diseases, inclement and extreme weather patterns, and herbicides. Furthermore, researchers seek improvement on winter hardiness of bermudagrasses (Anderson, Taliaferro, & Anderson, 1997).

Computer Technology

Casnoff (1997) and Corbley (1998) reported that current computer technology assists the superintendent with course design, renovations, maintenance, and management. Corbley further implied that through continued application of Global Positioning Systems (GPS) and Geographic Information Systems (GIS), precision can be achieved. Global Positioning Systems is a navigation and surveying tool developed by the U. S. Government, primarily for military purposes such as guiding troops and targeting missiles (Corbley). Furthermore, GPS becomes even more powerful when it is used in combination with Geographical Information Systems, a multi-layered, computerized map with an attached database containing extensive information about features on each layer of the map.

Data collected from the sky and the ground allow computers to model results before chemicals are actually applied to the golf course (Schmidt, 1998). Light analysis of turf cannot yet reveal the causes of turfgrass stress, but radiometers--instruments that analyze the colors contained in light--can pinpoint stressed turfgrass plots by reading the wavelengths of light reflected from them (Guertal, Shaw, & Copenhaver, 1999). Also, Rodriguez and Miller (2000) reported that near-infrared reflectance spectroscopy (NIRS) can be effectively used to schedule nitrogen applications on dwarf bermudagrasses.

The primary function of computerized, management programs for golf courses (such as GCS for Windows) is to organize and interpret grounds care activities, from daily work order scheduling, equipment maintenance, and inventory control to detailed budget analyses and labor-tracking (Goodman, 1999). In another direction, from fuel cells to robotics and satellites, technology is shaping the future for environmentally-friendly turf maintenance equipment (Perrault, 1999).

Miscellaneous Information

Subsurface air movement in golf green's drainage system can cool or heat a green, depending on the air temperature and whether the air is vacuumed or pressurized into greens (Dodd, Martin, & Camberato, 1999). The National Turfgrass Evaluation Program (NTEP) works to develop, improve, and evaluate turfgrasses (Shearman, 1996). Now more than ever, sound design must accommodate players of the game with a broad spectrum of abilities and limitations (Ochs, 1993). Such accommodations might include making the golf course more accessible and can also help speed up play and reduce the maintenance budget. Americans with Disabilities Act guidelines ensure the accessibility of the game of golf to all citizens without taking away from the fundamental nature of the game (Ginkel, 1999). Additionally, management personnel must employ practices that address the agronomic realities of the turfgrasses being grown. The desire to maintain tournament conditions on a daily basis at any given course is unrealistic (Cadenelli, 1992).

Teaching and Learning in Turfgrass

Conventional teaching methods provide important information on factors that are critical for successfully maintaining turfgrass (Danneberger, 1988). However, many instructors, managers, and students have exercised the team concept involving "on-site" training at golf courses during the course of study (Eggers, 2000; Page, 1999; Wagner, 1999).

Such challenges will require a strong educational base. Emphasis in agronomic curricula should include biology and chemistry, physical and mathematical sciences, and social and policy sciences and their application to technology on the regional, national and global levels (Jaques, 1998; Fry, et.al., 1998; Nielsen, 1992). The future health of the agronomic profession and its beneficiaries depends upon better addressing the need to train and to replace our human resources (Baltensperger, 1991). Furthermore, predictions and observations indicate a critical shortage of science teachers, researchers, and practicing professionals.

Surveys reflect an educational system that is well-structured to prepare future golf course superintendents for the next century (Dudeck & Peacock, 1991; Karnok, Hull, & White, 1989; McCrimmon, Karnok, & White, 1989; & Peacock & Dudeck, 1991). Most turfgrass course topics include turfgrass growth characteristics, establishment, mowing, fertilization, renovation, turfgrass diseases, insects, weeds, thatch, irrigation, drainage, environmental stresses, traffic, wear, and pesticide safety and handling (Karnok, Hull, & White, 1989; Karnok, Hull, & White, 1993).

Challenges face turfgrass education in the future. One challenge includes recruiting qualified students into turfgrass programs (Karnok, White, & Hull, 1993). They further reported another challenge as having sufficient funding, teaching faculty, and support staff to provide a quality education (Karnok, White, & Hull, 1993). At the graduate level, most students expressed a concern for environmental issues related to the turfgrass industry, but few students were addressing this issue in their research (McCrimmon, Karnok, White, & Hull, 1993). High school programs appear to be restricted to turfgrass management, plant propagation, greenhouse production, and landscape design (Bowen, 1986; Davis, 1990; Mityga, 1986).

In a study at Utah State University, plant science majors indicated the need for additional training in oral and written communication, computer science, and economics (Long, Straquadine, & Campbell, 1992). In another study, nearly all of the extension weed specialists in the southern U.S. felt that high school agricultural education teachers did not have enough background in weed science to provide training for their students

(Poston, Murdock, & Stapleton, 1992). In a survey, alumni of the University of Arkansas named information courses such as soils, chemistry, and crops as most important in undergraduate education but also emphasized the need for professional capabilities in communication skills, self-motivation, and practical application of knowledge (Davis, Bacon, & Beyrouty, 1991).

Encouraging students to analyze critically what they read, see, or hear does not necessarily make instruction more difficult (Anderson, 1992). Furthermore, as students learn the importance of information verification, they may be more likely to accept multiple reference requirements for term papers rather than just one author's viewpoint. Likewise, students may better understand why replication is necessary in experimental designs and why treatments without replication may lead to erroneous conclusions. Understanding this aspect of scientific methodology is important if golf courses are going to be further used as testing grounds in the future.

Internships can provide depth to an undergraduate degree while allowing students an opportunity to earn academic credit (Herring, Gantzer, & Nolting, 1990). Furthermore, the experience gained develops self-confidence, enhances problem solving skills, promotes professionalism, and improves employability (Seagle, 2001).

Dudeck and Peacock (1991) found that two-year graduates were being employed equally in golf course (33%) and lawn care/service industries (26%). But, the percentage of four-year turf graduates entering the golf course profession (40%) was higher than the two-year graduates. Graduation rates from both programs were not adequate to meet the needs but were expected to remain unchanged or increase in the future (Dudeck and Peacock, 1991).

Topical content at two-year schools equally emphasized lawn care and golf course management, which was in line with employment opportunities of their graduates

(Dudeck & Peacock, 1991). No major differences in methods of teaching, availability of published textbooks, facilities, and libraries were found between programs (Peacock & Dudeck, 1991).

Students must be taught certain fundamental facts to build their knowledge base in preparation for future employment (Anderson, 1992). Anderson (1992) further stated that an abundance of information exists, repeatedly warning educators about the impact of the information explosion as it relates to instruction and preparing students for employment. Cross (1985) stated that if educators are to prepare students for our knowledge-based society, they must provide them with cognitive skills and the capacity for self-direction.

Classroom instruction provides the principles behind proper turfgrass management practices, whereas field training exposes students to implementation methods (Danneberger, 1990). However, exposing students to the decision-making processes faced in turfgrass management is a difficult undertaking.

The development of computer simulation models for teaching in agriculture is an attempt to bridge the gap between classroom instruction and on-the-job training (Danneberger, 1990). Turfgrass Information and Pests Scouting (TIPS) was a pilot project involving the modification of existing Integrated Pest Management (IPM) concepts to demonstrate more efficient and effective fertilizer, pesticide, and water management needs for golf course operations (McCarty, Roberts, Miller, & Brittain, 1990). Furthermore, training technicians for public or private careers in turf management and increased grower interaction with the Cooperative Extension Service was achieved. Such programs should be explored in the turfgrass industry to maintain quality turf in a manner that meets the needs of participants and responds to environmental and economic concerns.

Certification has become a vital service to the professional golf course superintendent, and the professionalism demonstrated by individual certified members, and publicity by the Golf Course Superintendents Association of America (GCSAA) are the keys to the future of this program (Wagoner, 1991). Agronomists will be the problem solvers for all who need help in dealing with the intense interactions of people, soils, and plants in urban living and other social systems, in manufacturing, in wildlife preservation and conservation, and production agriculture (Duvick, 1993).

Identification of Categories

Among the forces of change are the rapid industrialization of the world that will be stimulated by decreasing political tensions; continuing internationalization of agriculture; gradual shifting from dependency on non-renewable to renewable resources; increasing public concern about natural resource conservation, environmental quality, and food safety; and a continuing decrease in the proportion of the population who have personal ties to farming and farmers (Holt, 1989). From this discipline review, the following categories are identified to direct the focus of this research:

1. Personnel education and staff development
2. Technology
3. Availability of turfgrass cultivars
4. Turfgrass management services
5. Legal issues
6. Chemical issues
7. Environmental issues
8. Best management practices
9. Other issues and/or circumstances

Curriculum Development

Curriculum, as a field of inquiry within education, is complex and difficult to conceptualize (Wiles, 1999). Wiles further stated "After only 80 years of existence, the literature is large, and boudaries that might define the area are vague (p. v). The Merriam-Webster's Collegiate Dictionary (2000) defined curriculum, derived from the Latin currere (meaning to run), as "the courses offered by an educational institution" or "a set of courses constituting an area of specialization" (p. 284). In addition, Finch and Crunkilton (1999) defined curriculum as "the sum of the learning activities and experiences that a student has under the auspices or direction of the school" (p. 11). Furthermore, Hass (1987) defined curriculum as "all the experiences that individual learners have in a program of education whose purpose is to achieve broad goals and related specific objectives, which is planned in terms of a framework of theory and research or past and present professional practice" (p. 5).

Wiles (1999) indicated that the four common definitions of curriculum by well-known curriculum leaders can be grouped as:

1. Curriculum as subject matter.
2. Curriculum as a plan.
3. Curriculum as an experience.
4. Curriculum as an outcome. (pp. 5-6)

Hass (1987) said that curriculum has been used to include:

1. A school's written courses of study and other curriculum materials.
2. The subject matter taught to students.
3. The courses offered in the school.
4. The planned experiences of the learners under guidance of the school. (p. 4)

Professional educators tend to define curriculum in a broad context, which focuses curriculum development into a group project since no one person is qualified in all areas (O'Kelley, 1969). O'Kelley further defined curriculum as "the sum total of the student's experiences and activities under the direction of the school, including teaching materials and methodology" (p. 29).

Sappe (1984) conducted a Delphi study on a national level in which a panel of curriculum experts were surveyed on the definition of curriculum. The experts were asked to select the definition of curriculum they preferred from a list of eight definitions of curriculum published in educational literature. A consensus of opinion could not be reached, but the definition chosen by the largest number of respondents, 44 percent, was as follows:

> All the objectives, content, and learning activities arranged in a learning sequence for a particular instructional area. An orderly arrangement of integrated subjects, activities, and experiences which students pursue for the attainment of a specific educational goal. (p. 126)

Without consensus, many broad-based definitions of curriculum continue to be used in the development of curriculum models.

Tyler (1957) stated that "curriculum is all of the learning of students which is planned by and directed by the school to attain its educational goals (p. 79). Furthermore, Tyler identified four critical questions that must be addressed in developing a curriculum:

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?

3. How can these educational experiences be effectively organized?

4. How can it be determined whether these purposes are being attained?

Even though there is no agreement among educators concerning a specific set of guidelines as a model for curriculum development, Gay (1980) reported that some consensus did exist surrounding components of curriculum development. Gay stated that curriculum development included identification of educational goals and objectives, selection and organization of content, learning activities, teaching processes, evaluation of student outcomes and effectiveness of the design process.

Identification of Curriculum Content for Agricultural Education

The purpose of the Smith-Hughes Act of 1917 was to develop vocational agricultural programs that prepared students to work on the farm as farmers (Gordon, 1999; Calhoun & Finch, 1982). The curriculum was designed to encompass a wide range of topics, but not to be a rural rendition of industrial education programs. Therefore, the first curriculum for secondary vocational agriculture programs was modeled after existing agricultural college curriculum (Wiles, 1999; Moore & Borne, 1985).

Agricultural educators aspired to be "comprehensive in coverage, scientific in method, and practical in impact and focus" (Committee on Agricultural Education, 1988, p. 57). Moore and Borne (1985) indicated that Rufus W. Stimson (Smith Agricultural School, Northhampton, Massachusetts) pioneered this approach and that he suggested that occupational analysis be used as a more objective and systematic procedure for determining curriculum content in vocational agriculture. Varnadore (1989) indicated that occupational analysis was used because of its effectiveness as a more systematic procedure in determining curriculum content for agricultural education programs.

Furthermore, educators in other disciplines were already effectively using occupational analysis (Flanders, 1988).

Terms referencing the analysis of an occupation and specific disciplines therein have varied between authors. According to Braden and Paul (1975), the primary function of occupational analysis was to break down the duties to determine the content of the job, thus using this information for curriculum planning and teaching. Braden and Paul used the terms "task," "job," "occupation," and "career" analysis, with job and task analysis being an important part of occupational analysis (pp. 58-59). Three types of analyses most commonly used in vocational agriculture include occupational analysis, enterprise analysis, and job analysis (Schmidt, 1926).

Wheeler (1948) reported that the vocational agriculture curriculum in Georgia was typical of the practices employed by other states. His statement was:

> The instructional program became definitely based on the problems growing out of a job analysis of the boy's home practice program and projects . . . The procedure in determining vocational course content in a given community followed the pattern given below: . . . A careful systematic study of the family, and the environment on the farm, including both the social and economic conditions . . . scope of production, and value of farm enterprises, including crops, garden, orchard, livestock, pasture, and forestry. (pp. 246-247)

Herren (1987) reported that a variation of occupational analysis was used to plan curriculum content based on home projects.

According to Drawbaugh (1966), vocational agriculture teachers were most familiar with farming and well prepared to select curriculum content for students. He wrote:

> Teachers of agriculture came from farms, and were themselves former Future Farmers, and were graduates of the state university with a degree in agricultural education. The teacher of agriculture not only knew vocational agriculture, he experienced it, was part of it, and lived it . . . The course of study was assumed valid primarily because the teachers who were also the course builders came via the same road they were advising their students to travel. (p. 10)

The Vocational Education Act of 1963 (Public Law 88-210) provided for training in non-farm occupations, thus vastly extending the realm of the vocational agriculture programs (Gordon, 1999; Calhoun & Finch, 1982). Its purpose was to strengthen and improve vocational education and expand the coverage into disciplines other than originally authorized (Phipps, 1980). Flanders (1988) reported that "the programs were expanded to train workers for new and emerging occupations such as those in the area of forestry, horticulture, natural resources, and agribusiness" (p. 25).

The Vocational Act of 1963 presented teachers of vocational agriculture with a new challenge, that of planning course work for a wide variety of non-farm agricultural occupations (Gordon, 1999). Such emphasis was recognized by Drawbaugh (1966), who said that "preparing a course of study for off-farm agricultural occupations is much more complicated than preparing one for traditional agriculture" (p. 10).

The Carl D. Perkins Vocational and Applied Technology Education Act of 1990 signaled congressional interest in emphasizing the application of the academic and vocational skills necessary to work in a global technologically advanced society (Gordon, 1999). Gordon indicated that this law was directed at all segments of the population and set the stage for the following three-pronged approach for better workforce preparation by emphasizing:

1. Integration of academic and vocational education.
2. Articulation between segments of education engaged in workforce preparation.
3. Closer linkages between school and work. (p. 79)

Congress thus provided a template for the vocational education portion of the merging strategy for preparing the workplace of the future.

Identification of Curriculum Content for the Future

Finch and Crunkilton (1999) indicated that the actual selection of a curriculum content determination strategy appears simple, but the selection process can be complex. They reported seven strategies for determining curriculum content for vocational education: philosophical basis, introspection, DACUM, task analysis, "all aspects" of industry approach, critical incident technique, the Delphi technique, and the synthesis of strategies approach (a combination).

The philosophical basis strategy was the beacon for curriculum developers before more refined means were developed. This subjective strategy is that philosophy may be used in vocational education as a foundation to determine the framework for the curriculum offered (Finch & Crunkilton, 1999). They further indicated that a sound philosophy could have a broad impact on curriculum development, but this impact is not as great in the area of specific technical content.

According to Finch and Crunkilton (1999), introspection "basically consists of examining one's own thoughts and feelings about a certain area. However, within the context of curriculum content determination, this strategy may involve either an individual or a group" (p. 140). Furthermore, this method may not always lead to a valid content and might contain the bias of the group or individual making the curriculum decisions.

The Develop A CurricUM (DACUM) approach was described as a variation of the introspection approach (Finch & Crunkilton, 1999). The DACUM approach relies on data from experts employed in the occupation being studied and is a systematic process for content determination. In the DACUM process, a facilitator leads a group of ten to twelve experts through a series of steps wherein areas of competence and behaviors for a particular occupation are explored.

Finch and Crunkilton (1999) indicated that few content determination strategies have seen such widespread use as the task analysis. They defined task analysis as "the process wherein tasks performed by workers employed in a particular job are identified and verified" (p. 147). Furthermore, just as the name "task analysis" implies, potential tasks are identified and then verified by job incumbents, with the resultant analysis serving to determine which tasks are actually associated with a particular job. Sappe (1984) reported no agreement on the definition of task analysis among curriculum experts. Throughout the literature, the term "task analysis" has been used interchangeably with "job analysis" and "occupational analysis."

Finch and Crunkilton (1999) stated "By using 'all aspects,' curricula can be created that are based on encompassing and powerful themes" (p. 154). Furthermore, content for programs designed to encompass broad themes such as manufacturing or agricultural technology must be selected giving consideration for both workplace breadth and depth. The thematic curriculum is "a set of organized experiences such as programs, courses, and other school-sponsored activities that provide students with exposure to a broad, predominant theme" (Finch, C. R., Frantz, N. F., Mooney, M., & Aneke, N. O., 1997, p. 1).

Finch and Crunkilton (1999) defined critical incident as "procedures for collecting direct observations of human behavior in such a way as to facilitate their potential usefulness in solving practical problems" (p. 156). Furthermore, an incident was defined as "any observable human activity that enables inferences and predictions to be made about the person performing the act" (p. 156). The critical incident technique has allowed for the collection of data relative to affective behavior. A composite picture of job behavior may be beneficial in developing appropriate curriculum content to enhance the affective learning in the program.

According to Finch and Crunkilton (1999), the Delphi technique has much applicability when curriculum content is being determined, and focuses more directly on the future of a particular area. They stated that "the Delphi technique enables experts to speculate individually and then reach consensus collectively regarding the content necessary to prepare workers, even in the areas where no workers exist at the present time" (p. 159). Use of techniques such as Delphi has been labeled "futuring" or "futures research."

It is evident that much diversity exists among curriculum content determination strategies (Finch & Crunkilton, 1999; Levary & Han, 1995). According to Finch and Crunkilton, strategies seem to apply more readily to one area than to others, thus a synthesis of strategies may be an option understanding that:

1. Using a philosophical basis works best for identifying awareness content but is less useful with exploration and preparation content.
2. Although task analysis may be used to focus on specific aspects of an occupation, it does not incorporate the futuristic aspects of the Delphi approach that are so useful for identifying tomorrow's as well as today's content.

3. The use of multiple strategies has the greatest potential for deriving high-quality content.
4. Each strategy has it's own strengths; however these strengths follow a rather narrow band of content.
5. The application of several well-chosen strategies to a particular area should produce content that is more relevant to the needs of today's students, who are tomorrow's workers and citizens. (p. 160)

An analysis of curriculum content determination strategies is found in Figure 1.

Vocational education curriculum content based on the past or present will not effectively prepare students for the future. Strategies addressing the future must be a part of curriculum development. Finch (1988) stated that "the judicious selection of futures-oriented content will complement general and present-oriented content, thereby better preparing our graduates to cope with the future work world" (p. 9).

Futures Research

Often the education profession is captivated with the present while still focusing on the past for answers. This captivation could misdirect the planning for the future of vocational education and its workers. However, this misdirection could be avoided if only a more futuristic approach to research is adopted. The alternative in forecasting the future may involve a crystal ball or Ouija board. Most well-educated people pay little attention to fortune tellers, psychics, and soothsayers. Flanders (1988) stated "some still view the efforts of futurists to forecast the future as foolhardy, an unsavory application of research techniques, and best left to the gazers of crystal" (p. 38). However, in the last few decades, scientists and other scholars have focused more attention and greater credibility on predicting the future (Schoonmaker, 1981).

Applicability to Vocational and Technical Education

Strategy	Ease of Data Collection	Objectivity	Validity	Awareness of Work	Exploration of Work	Preparation for Work
Philosophical Basis	+	-	?	+	?	-
Introspection	+	-	?	?	?	?
DACUM	?	+	+	-	-	+
Task Analysis	-	+	+	-	?	+
"All Aspects"	?	?	?	+	+	+
Critical Incident Technique	-	?	+	-	+	+
Delphi Approach	-	?	?	+	+	?

Figure 1. Analysis of Curriculum Content Determination Strategies (Finch & Crunkilton, 1999).

The science of studying the future has also been labeled prognostic, futuristic, prospection, forecasting, futurecasting, futurism, futurology, and futures research (Dickson, 1971). There has not been a convergence of opinion on the definition of terms used in futures research. Boucher (1977) stated that "though the term 'futures research' has achieved general currency, it still is without an accepted definition" (p. 6). Simmonds (1983) defined futuring as "the process of getting from where you are to where you think you would like to be" (p. 21). The World Future Society BULLETIN (Cornish, 1976) defined futures research as "a term used to denote the study of the future" and futurism as "the mood or movement that emphasizes the importance of seriously thinking about planning for the future" (p.8).

Walters (1988) stated that "the future of all vocational education is tied to a commitment to develop a curriculum framework that will move programs forward" (pp. 38-39). Mendell (1985) discussed the reason for studying the future with an example of corporate planning:

> Forecasting is a step in learning about the environment and how to respond to the environment....First you guess the future state of the environment, then you guess a proper corporate response, then you undertake action, and finally you revise your plans if they are not working exactly as predicted (and they never work exactly as predicted). What is learned? Quite a lot. (pp. 4-5)

According to Roberts and Roberts (1987):

> Curriculum reform implies that we plan ahead much the same as when we try to shoot moving ducks in a shooting gallery. We have to aim where the duck will be when the bullet arrives, not where it was when the shot was fired (and there is no silver bullet). (p. 4)

Cornish (1976) endorsed the study of the future as follows: "The past is gone, and the present exists only for a fleeting moment. Everything that we think and do from this moment can only affect the future." (p. vii). Gallup and Proctor (1984) stated that "a significant degree of protection is possible through the identification and analysis of the powerful future forces in our midst" (p. 11). Brighton (1987) indicated that since our actions influence the outcome, planning even helps create a desired future. It is impossible to know what will happen in the future, but in planning, educators will be more prepared for the possible outcomes (Iverson, 1993a).

The Delphi Technique

Delphi is a method for structuring a group communication process so that the process is effective in allowing a group of individuals as a whole, to deal with complex problems (Linstone & Turoff, 1975). The Delphi method is based on a structured process for collecting and distilling knowledge from a group of experts by means of a series of questionnaires interspersed with controlled opinion feedback (Adler & Ziglio, 1996). It consists of a series of questionnaires of a group of individuals whose opinions are of interest, with questionnaires continuing in "rounds" where the anonymous responses of participants are submitted to the entire group for comment until consensus, divergence, or stasis of opinion is reached (Adler & Ziglio, Hencley & Yates, 1974). Delphi is also an interdisciplinary, inter-subjective, futures research technique that allows translation of qualitative data for quantitative analysis and is particulary useful when the field of interest is too new to have adequate historical data for the use of other methods (Lang, 1996). According to Helmer (1966), Delphi represents a useful communication device among a group of experts and thus fascilitates the formation of a group judgement.

Wissema (1982) underlines the importance of the Delphi method as a mono-variable exploration technique for technology forecasting. He further states that the Delphi method has been developed in order to make discussion between experts possible without permitting a social interactive behavior as it may happen during a normal group discussion and hampers opinion forming.

The Delphi method was developed by Kaplan, Skogstad, and Cirshick (1949) and refined in 1953 by Helmer and Dalkey of the RAND (an acronym for Research and Development) Corporation to answer the U. S. Air Force's question about the likely outcome of a Soviet nuclear attack on the United States (Linstone & Turoff, 1975). The Delphi concept may be viewed as one of the spinoffs of defense research (Linstone & Turoff, 1975). "Project Delphi" was the name given to an Air Force-sponsored RAND Corporation study which started in the early 1950's and concentrated on the use of expert opinion (Dalkey & Helmer, 1963). The selection of the name "Delphi" was chosen due to the similarity of the project methodology with the procedures employed by the oracle at Delphi in ancient Greece. The word "Delphi" refers to the hallowed site of the most revered oracle in ancient Greece (Fowles, 1978; Uhl, 1983). Forecasts and advices from gods were sought through intermediaries at this oracle. Since then, the Delphi has been used many times, by most disciplines, for a variety of reasons, and under many permutations (Adler & Ziglio, 1996; Finch & Crunkilton, 1999).

According to Wissema (1982), the Delphi has been effectively used in industry, government, and academe. It has simultaneously expanded beyond technological forecasting (Fowles, 1978). Since the 1950's several research studies have used the Delphi method, particularly in public health issues and education areas (Adler & Ziglio, 1996; Cornish, 1976).

The objective of most Delphi applications is the reliable and creative exploration of ideas or the production of suitable information for decision making. The Delphi method recognizes human judgement as legitimate and useful input in generating forecasts (Fowles, 1978). Furthermore, single experts sometimes suffer biases; group meetings suffer from "follow the leader" tendencies and reluctance to abandon previously stated opinions.

There are no hard and fast rules for Delphi implementation (Turoff & Hiltz, 1995). However, Lang (1996) suggested that all Delphi studies follow a broad procedural outline which includes:

1. The problem is identified.
2. An expert panel is developed.
3. The panel is presented the problem and asked to respond.
4. Responses are synthesized into a series of statements.
5. The synthesized statements are submitted to the panel.
6. The panel responds.
7. The process continues until convergence, divergence, or stasis is identified.

Advantages of the Delphi Technique

Several authors have expressed the advantages of the Delphi technique over interacting groups or survey techniques (Finch & Crunkilton, 1999; Brodzinski, 1979; Brooks, et. al., 1978; Cyphert & Gant, 1970; Combs, 1985; Hartman, 1981; Reeves & Jaunch, 1978). The following advantages were identified by Brodzinski, and Adler and Ziglio (1996):

1. Delphi is a well-defined, reliable procedure and produces quantifiable results.
2. The procedure avoids psychological factors of persuasion, overcomes reluctance to abandon publicly expressed opinions, and discourages the bandwagon effect.
3. Allows participants to remain anonymous.
4. The expressed opinions represent well-reasoned conclusions of intercommunicating experts.
5. By organizing and controlling the feedback to respondents, the procedure increases the accuracy of the forecasts.
6. Individual ratings of self-confidence on each item can be converted to an estimate of the accuracy of the group response.
7. Allows sharing of information and reasoning among participants.
8. Conducive to independent thinking and gradual formulation.
9. Can be used to reach consensus, even among groups hostile to each other.
10. The Delphi technique is relatively inexpensive.

Brooks, et. al. (1978) suggested that a major advantage is the ability to obtain group responses without face-to-face meetings, saving time and expense. This allows the use of experts from widely-spaced geographical areas at considerably less expense. Another advantage is that one respondent's opinion carries the same weight or value as any other (Adler & Ziglio, 1996; Combs, 1985).

Concerns Associated with the Delphi Technique

Cetron (1969) listed seven drawbacks of using the Delphi technique which include:

1. Panel members dislike beginning with a blank piece of paper.
2. The extensive number of interactions required by the Delphi process results in a heavy investment of time.
3. After several rounds, the panelist may be faced with evaluating projections in areas totally outside his area of expertise.
4. A lack of goal orientation leaves the questions: When has the information been refined enough?
5. Efforts to determine event feasibility and desirability are barely addressed.
6. Most importantly, no effort is made to (a) determine event interrelationships; (b) prepare "menus" of alternate short-, mid-, and long-range goals; or (c) identify the supporting events desirable and necessary to make these goals achievable.
7. The basic design of such a technique precludes the (hopefully empathetic) give-and-take potentially possible in face-to-face confrontation. (p. 146)

Morrison, Renfro, and Boucher (1984) identified many problems with Delphi studies. An initial concern was that "no established conventions yet exist for any aspect of study design, execution, analysis, or reporting" (p. 49). Their belief was that only through practice can one discover the four key factors of significance about the Delphi technique, which included:

1. The amount of information and data garnered through the process can and will explode from round to round.
2. Good questions are difficult to devise, and the better the design of the questions asked, the more likely it is that good participants will resign from the panel out of what has been called the BIF factor--boredom, irritation, and fatigue--because they will be asked the same challenging

questions again and again for each trend or event in the set they are forecasting.

3. The likelihood of such attrition within the panel means not that the questions should be cheapened but that large panels must be established so that each participant will have fewer questions to answer, which is very time-consuming.

4. Delphi itself does not include procedures for synthesizing the entire set of specific forecasts and supporting arguments it produces, so that when the study is "completed" the work has usually just begun. (p. 49)

These authors see a threat to the consensus phenomena as seemingly caused by two factors:

1. The panelists simply reread the questions and undertook them better.

2. The panelists are biased by the group's response in the preceding round of interrogation. (p. 50)

They cautioned investigators to use great care when interpreting results.

Application of the Delphi Technique

The Delphi technique was made public in the 1960's and has become a common method of futures research (Adler & Ziglio, 1996; Judd, 1971; Linstone & Turoff, 1975; Fisher, 1978; Hunt & Brooks, 1982; Weatherman & Swenson, 1974). Linstone and Turoff stated:

> It is interesting to note that the alternative method of handling this problem at that time would have involved a very extensive and costly data-collection process and the programming and execution of computer models of a size almost prohibitive on the computers available in the early fifties. Even if this alternative approach

> had been taken, a great many subjective estimates on Soviet intelligence and politics would still have dominated the results of the model. Therefore, the original justification for this first Delphi study are still valid for many Delphi applications today, when accurate information is unavailable or expensive to obtain, or evaluation models require subjective inputs to the point where they become the dominating parameter. (p. 10)

Furthermore, Linstone and Turoff (1975) described some areas, in addition to forecasting, where Delphi had an application. Such areas included:

1. Gathering current and historical data not accurately known or available.
2. Examining the significance of historical events.
3. Evaluating possible budget allocations.
4. Exploring urban and regional planning options.
5. Planning university campus and curriculum development.
6. Putting together a structure of a model.
7. Delineating the pros and cons associated with potential policy options.
8. Developing casual relationships in complex economic or social phenomena.
9. Distinguishing and clarifying real and perceived human motivation.
10. Exposing priorities of personal values and social goals. (p. 4)

They further stated that the conditions of the problem usually indicate whether the Delphi technique is a valid methodology. Thus, the Delphi technique may be employed when:

1. The problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collaborative basis.

2. The individuals needed to contribute to the examination of a broad or complex problem have no history of adequate communication and may represent diverse backgrounds with respect to experience and expertise.
3. More individuals are needed than can effectively interact in a face-to-face exchange.
4. Time and cost make frequent group meetings infeasible.
5. The efficiency of face-to-face meeting can be increased by a supplemental group communication process.
6. Disagreements among individuals are so severe or politically unpalatable that the communication process must be refereed and/or anonymity assured.
7. The heterogeneity of the participants must be preserved to assure validity of the results, i.e., avoidance of personality ("bandwagon effect"). (p. 4)

Uhl (1983) shared:

> Since the mid-1960's, the Delphi technique has been used in business, government, industry, medicine, regional planning, and education over a variety of situations, including futures forecasting, goal assessment, curriculum planning, establishment of budget priorities, estimates concerning the quality of life, policy formulation, and problem identification and solutions. (pp. 82-83)

Articles on procedures, modifications, and case studies are found in publications by Adler and Ziglio (1996), Brodzinske (1979), Brooks, Litchfield, and Greene (1978), Cunningham (1982), Delbecq, Uhl (1983), Iverson, 1993b; Weatherman and Swenson (1974). Olaf Helmer (cited in Weatherman & Swenson, 1974) stated:

> The Delphi procedure operates on the principle that two heads are better than one in making subjective conjectures about the future, and that experts . . . will make conjectures based on rational judgment and shared information rather than merely guessing, and will separate hope from likelihood in the process. (p. 97)

The Delphi technique uses a sequence of questionnaires to obtain information. After each round, a summary of the data collected is supplied to the panel for consideration in the next round. Feedback is used to get respondents to reconsider or defend their answers in order to achieve consensus (Brooks, et. al., 1978). The general procedure in applying the Delphi technique has been as listed (Uhl, 1983):

> 1. The participants are asked to list their opinions on a specific topic such as curriculum or planning priorities.
> 2. The participants are then asked to evaluate the total list by criterion, such as importance, chance of success, etc.
> 3. The participants receive the list and a summary of responses to the items. If the participants are in the minority, they are asked to revise their opinions, indicate their opinions, or indicate their reasons for remaining in the minority.
> 4. The participants again receive the list, updated summary, minority opinions, and another chance to revise their opinions. (p. 82)

<u>Selection of the Panel of Experts</u>

The selection of the panel of experts is critical to the validity and reliability of the study. Panel representativeness, appropriateness, competence, and commitment must be considered in the selection process (Adler & Ziglio, 1996). The size of the panel of experts has varied with past studies. Cyphert and Gant (1970) suggested that a panel size smaller than 50 is usually appropriate, and Delbecq, et. al. (1975) indicated that few new ideas are generated within a homogeneous group once the size exceeds thirty participants.

Weatherman and Swensen (1974) suggested that panel members should be chosen in a logical manner so that they are typical of the population they represent. Renzulli (1968) used a peer nomination process and Sutphin (1981) used professional association officers in a nomination process to select a panel of experts. Flanders (1988) suggested that, in an effort to eliminate researcher bias, it seems logical to use a peer nomination or a criteria-referenced panel selection process.

Determining Consensus

A basic assumption of the Delphi technique is that consensus of the opinions of experts indicates a high probability of an accurate forecast. With each succeeding round of a Delphi instrument there should be a convergence of opinion as individual estimations move closer to the statistical summary of the group responses (Weatherman & Swensen, 1974; Adler & Ziglio, 1996; Martorella, 1991). On the second and each successive round of the Delphi instrument, the respondents are supplied with summarized information concerning the previous round and their responses to the previous round. Respondents are asked to reconsider their answers based on this information (Uhl, 1983). The Handbook for Continuing Future Studies in Education (1984) stated that this process allows for cross-fertilization of thinking and that each round should achieve more of a consensus than the previous round.

Consensus was defined by Hill and Fowles (1975) as "agreement among at least 60% of the respondents that the event had a 50% or 90% probability of occurring within a ten-year period" (p. 184). Cunningham (1982) reported that a cut-off percentage is used to determine consensus and that, if a five to ten unit scale is used, the consensus is achieved when the interquartile range is no larger than two units. Flanders (1988) stated that the selection of a criterion to measure consensus seemed to be an arbitrary decision in most cases.

Another issue related to consensus is stability (Dajani, Sincoff, & Talley, 1979). Stability indicates that respondents were not changing their answers significantly on succeeding rounds of the Delphi instrument. Stability has been a concern only on group responses. Linstone and Turoff (1975) addressed stability as follows:

> Because the interest lies in the opinion of the group rather than in that of individuals, this method is preferable to one that would measure the amount of change in each individual's vote each round. Using the 15% change level to represent a state of equilibrium, any two distributions that show marginal changes of less than 15% may be said to have reached stability. (pp. 227-228)

Selection of the Delphi Technique

Flanders (1988), Varnadore (1989), and McAllister (1992) used the Delphi technique to determine curriculum needs for agricultural programs in the 21st century. Sappe (1984) utilized the Delphi technique to determine group responses on the definitions of curriculum terms. L. Combs (1985) used the technique to predict futures for public secondary schools and S. Combs (1994) used it to determine postsecondary and adult home economics education. White (1988) used the technique to determine curriculum content for analytical chromatography instrumentation course work.

This researcher has determined that the Delphi technique is the best futuring method for determining curriculum content for turfgrass course work in agricultural education based on future characteristics of the turfgrass industry.