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The Canadian Grain Grading System and the Operational Efficiency of the Vancouver Grain Terminals

by

Dale Vernon McKeague

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Science

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Abstract

Problems related to the grain handling and transportation system have been investigated by Royal Commissions and other groups throughout the past century. However, handling and transportation problems still exist in the grain industry in Canada. This study focuses on the interrelationship between the Canadian grain grading system and the operations of terminal grain elevators at Vancouver and the problems arising from these interrelationships.

The objectives of the study were threefold, (a) to determine and describe the effects of the grading system on terminal elevator operations, (b) to quantify the cost attributed to the grading system and (c) determine the effect of handling additional grades on terminal elevator throughput. Deispite data limitations, these goals were pursued through description of the terminal handling process, as well as through scenarios to investigate the effects of the Canadian grain grading system on the various terminal operations and the effects of handling additional grains and grades.

Available data indicates that there is a relationship between the grain grading system and the throughout of the terminal elevators at Vancouver. The present system of grading wheat in Canada has a deleterious effect on terminal throughput through delays in unloading due to grading, a reduction in cleaning capacity and a reduction in usable storage space. In addition, the cost of operations at the terminals is higher than necessary due to labour requirements necessitated by the present method of grading grain at the terminals. The throughput of the terminals is decreased by additional grains or grades being handled. Estimates presented, based upon the most likely constraint being within the system, suggest possible throughput increases of up to 60 percent by deleting 5 grade and protein segregations in wheat.

Improvements in the system require additional research determining the benefits to Prairie producers of the present grain grading system. Additional issues which need to be investigated include the and benefits of alternate locations for grading grain, as well as the costs and benefits of using the present system of protein segregations in Hard Red Spring Wheats.

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To Lorraine and our new daughter Maureen, I dedicate this thesis.

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I. Introduction

The world grain market in which Western Canadian producers sell their product is becoming increasingly competitive. Many of Canada's traditional customers such as the Western European countries, India and the Peoples Republic of China have increased grain production. The result is a loss of traditional markets and increased competition for alternate markets as former net importers make the transition to becoming net exporters. To remain competitive in world grain trade, it is important that the Canadian grain marketing and transportation system becomes as efficient as possible in delivering product to customers.

Western Canadian grain producers have been actively engaged in world grain trade throughout the past century. During this period, improvements have been made to the grain handling and transportation system. Many of these improvements have resulted from 13 major Royal Commissions and inquiries into the grain industry and the grain handling and transportation system.[1] The first of these inquiries and commissions was the Senkler Commission of 1899, the latest was the Snavely Commission of 1980.

The 1977 Hall Commission stated that "The persistent issues can be categorized into two broad groups: organization of the grain handling and transportation system and freight rates."[2] The freight rate problem will be put to rest, if not solved, with the resolution of the Method of Payment debate which resulted from the passage of Bill C-155, *The Western Grain Transportation Act* in 1983.

The other broad category of problems stated by the Hall Commission, that of the organization of the grain handling and transportation system, raises questions concerning efficiency which must be answered if Canada is to remain competitive in world grain trade. These questions may include:

1) What is the most effective mechanism for selling prairie grain--the present dual system, with the Canadian Wheat Board (C.W.B.) responsible for all export wheat, oats and barley, and the open market (private trade) responsible for all other grain exports, or an open market system with a voluntary board such as existed between 1935 and 1943? and

2) What changes can be made to the grain handling and transportation system which will

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[1] This excludes the Gilson Report on the statuatory freight rates and the subsequent passage of Bill C-155, *The Western Grain Transportaton Act*, 1983.
[2] Hall Commission, *Grain and Rail in Western Canada* Vol.1(Ottawa:Supply and Services, 1972) p.19

ensure that customer requirements are satisfied and how best to [illegible] these changes without placing undue financial burdens on any of the participants in the prairie grain industry?

The financial burden of inefficiencies in the grain handling and transportation system has in the past been carried by many of the participants in the grain industry as well as by the Canadian taxpayer. However, the brunt of this burden has been on the producer[3]

The primary cost to producers has been lost and deferred sales--sales which could have been made, but due to problems within the system, were not completed. Lost and deferred sales not only represent an income loss to producers for a crop year, but also possibly increase outlay for on-farm storage. In additon there could be a reduction in customers' trust of Canada as a reliable supplier. This might reduce future sales. Another cost borne by producers is the cost of demurrage. Demurrage is payment to ship owners for delays in loading after a reasonable time in port. The average cost of demurrage at Vancouver is $11,000-$12,000 per day per ship.[4] The total demurrage cost for crop year 1982/83 for C.W.B. grain alone was 9.1 million dollars (or approximately $60 per permit holder).[5]

Increasing the efficiency of the Canadian grain handling and transportation system is imperative if C.W.B. export projections of 36.0 million tonnes[6] by 1989/90 is to be feasible. Fifty percent of the projected exports (18.0 million tonnes) are expected to move through the Pacific Coast terminal elevators, which in 1983/84 handled a record 12.58 tonnes.[7] The estimated 43 percent increase in throughput at the Pacific Coast is to be carried by the existing terminals at Vancouver and the new Prince Rupert terminal. These terminals combined have an estimated 15.7 million tonne maximum capacity[8], falling

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[3] In any marketing system the costs of marketing are passed either on to the the customer or back to the producer. Costs due to inefficiencies in the grain handling and transportation system cannot be passed to the customer due to the competitive nature of world grain trade. Therefore, the costs are passed back to the producer and are reflected in the prices which are received at the farm gate.

[4] Personal Communication with Mr. Gary Dewar, Manager of Terminal Operations for Alberta Wheat Pool, Vancouver, June 1984.

[5] Canadian Wheat Board, *Annual Report 1982-83* (Winnipeg: C.W.B., 1984), p.37

[6] Personal Communication with Mr. John Marchiori, Alberta Wheat Pool Vancouver, February 1985.Based on projections he received from C.W.B.

[7] C.W.B. figures received from Alberta Wheat Pool Vancouver, February 1985.

[8] Canada Grains Council,*Prospects for the Prairie Grain Industry 1990* (Winnipeg: C.G.C., 1982) p.247

2.5 million tonnes (13.9 percent) short of the projected 18.0 million tonne throughput in 1989/90. To handle this proposed 43 percent increase in Pacific Coast grain exports, each of the existing terminals will need to increase throughput. An increase in the operational efficiency of the terminal elevators may bring about the required throughput increase.

Another area in which efficiency improvements must be made is in the ability of the system to deliver the required grain to the terminals. Increases in the amount of grain delivered to the terminals in the early 1970's were attributed to the following factors cited by the Canada Grains Council in 1973:

1. the block shipping system;
2. car pooling and improved port coordination;
3. partial work week extension (i.e. Saturday loading and unloading);
4. grade options possible within large long term contracts, in a sellers market;
5. leasing of additional rolling stock and diesels by the railways.[9]

Since this Grain Council report was written, several other factors have contributed to the increase, such as;

1. The purchase of hopper-bottom grain cars by the Government of Canada, the Provinces of Alberta and Saskatchewan, the C.W.B. and additional cars leased by the federal government. These cars have essentially replaced most of the box cars in the grain fleet. The replacement of box cars with hopper cars has facilitated faster car loading and unloading; as well, hopper cars hold more grain per car.[10]
2. The pooling[11] of canola/rapeseed as well as Board grain at Vancouver assisted in the increase in throughput capability.

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[9] Canada Grains Council, *Grain Handling and Transportation: State of the Industry* (Winnipeg: C.G.C., 1973) p.89

[10] Box cars hold 40-60 tonnes of grain whereas hopper cars hold between 70-100 tonnes. In additon, box cars have to be coopered (the doors lined with reinforced cardboard) prior to loading. Box cars are unloaded at the terminal using a box car dumper which literally shakes the grain out of the car, an operation which takes approximately 5 minutes. Hopper cars are pulled directly over the unloading pit and are unloaded in less than 2 minutes.

[11] Car pooling allows the railways to spot cars at terminals irrespective of the original consignee. This process eliminates much of the car switching between the two railways, a time consuming and costly operation. An example of pooling occurs when grain consigned to Alberta Wheat Pool (C.P. track) arrives on the Canadian National(C.N.) track and is delivered to Saskatchewan Wheat Pool. Conversely, grain arriving for Saskatchewan Wheat Pool on C.P. track is delivered to Alberta Wheat Pool. The Grain Transportation Agency ensures that the companies consignments are balanced with their receipts.

3. The block shipping system was replaced in 1984 by the train run system to increase the amount of grain arriving at the terminals.
4. The formation of the Grain Transportation Agency (G.T.A.) coordinating the movement of grain cars has increased transportation potential.

These improvements have increased Canada's capability to export grain to the extent that 1983/84 shipments set an all time record. However, improvements and changes along these lines will continually be required in order to keep pace with the competitive world market.

A. Operational Efficiency

Efficiency is an engineering term which economists use in the measurement of economic relationships between inputs and outputs. In agriculture, efficiency is often used as a measure of how well the market is performing. Measurement of efficiency is carried out through the determination of the ratio of inputs to outputs and then the comparison of this ratio to the optimum ratio which could be obtained from the use of these factors. "Operational efficiency pertains to how well the physical part of the marketing is done--the quantity and quality of service performed relative to resources used."[12] For example, operational efficiency concentrates on the physical functions of marketing such as storage, transportation and processing.

Operational efficiency is just one part of the measurement of Market Efficiency. The other ratio included is the measurement of exchange (pricing) efficiency. "Exchange efficiency focuses on the coordination of activities as the product flows through the marketing process. Included here are the buying and selling (title transferring) market functions."[13] Neither of these two concepts operates in a vacuum as an interrelationship exists between the two concepts.

The measurement of operational efficiency is mainly carried out on the basis of cost. A least-cost method of producing marketing services is the most operationally efficient mechanism. However, the attainment of this least-cost method is subject to constraints placed on the industry by both internal and external agencies.

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[12] Harold F. Breimyer, *Economics of the Product Markets of Agriculture* (Ames :Iowa State University Press, 1976), p.125

[13] A.A. Warrack. "A Conceptual Framework for Analysis of Marketing Efficiency," *Canadian Journal of Agricultural Economics*, 20(1972), p.11

The Canadian grain grading system[14] has in the past concentrated on the exchange efficiency of grain marketing. Grading is carried out in order to price grains for both sellers and buyers. However, in the process of making the grain marketing system more efficient in an exchange sense, the effects which this priority exerts on the operational efficiency of the system have often been ignored.

B. Problem

The specific problem examined in this study is the effects of the present system of grain grading in Canada on the operational efficiency of Pacific Coast terminal elevators. Research carried out by Hoar, *et al*. suggests that there is a significant relationship between the number of grain grades received by primary elevators and the average cost of operation. They also indicate that the system is currently capable of handling the number of grades received at the primary elevators. This same study found that as the number of grains received at primary elevators increased, the average cost per grain decreased.[15]

Primary elevators tend to receive grain from a localized area with a common microenvironment. The microenvironmental effects act to keep the number of grains and grades low at the primary elevator level. However, the terminal elevators receive grain from throughout Western Canada. The end result is that the terminals receive more varied grades of grain and more species of grains than do primary elevators. Despite this factor, it is hypothesized that the findings at the primary elevator level are relevent to the terminal elevators.

C. Objectives

The primary objectives of this study are:

1. to determine and describe the effects which the Canadian grain grading system has on the operational efficiency of the Pacific Coast terminal elevators.
2. to quantify the additional cost to terminal operations attributed to the current grain grading system.

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[14] See a discussion of grain grading in Chapter 3 of this thesis.
[15] W.J.Hoar, M.H.Hawkins and M.L.Lerohl, "Effects of Domestic Grain Grades on the Operational Efficiency of Alberta Primary Elevators," *Agriculture and Forestry Bulletin* Vol 6(No.4), (Edmonton, Alberta: University of Alberta, 1983), p.55

3. to determine the effects of handling additional grains or grades on terminal elevator throughput.

D. Scope and Limitations

The emphasis of this thesis is to determine the relationship between the Canadian grain grading system and the throughput of the Pacific Coast terminal elevators. This study focuses only on the cost of the grading system as it affects the terminal elevators, specifically on the Pacific Coast of Canada. There has been no analysis of the benefits which are accrued through grading, so that a benefit-cost relationship cannot be described.

The anaylsis in this thesis is mainly descriptive due to the lack of information on the operations studied. Statistical analysis of cross-sectional accounting data, such as costs of operations for the terminals, has some limitations.[16] The terminal elevators at the Pacific Coast differ with respect to size, configuration and age. Therefore, a statistical analysis comparing them was not undertaken in the study.

The study concentrates on the effect of the whole system of grading including location of grading, time of grading and the two standards system employed.

E. Sources of Data

Data used in this study were obtained from several sources. The data pertaining to the cost of operation were obtained through the courtesy of Alberta Wheat Pool, a producer owned cooperative grain company. The data used in this study are from Alberta Wheat Pool's terminal elevator facility in Vancouver and Pacific Elevators Limited which is managed by the Alberta Wheat Pool. Other data used were obtained from published and unpublished reports of the Canadian Grain Commission, Canada Grains Council, Canadian Wheat Board, and Grain Transportaion Agency, all with head offices located in Winnipeg, Manitoba.

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[16] For a complete discussion of the limitations of statistical analysis on cross-sectional accounting data, see, Ben C. French, "The Analysis of Productive Efficiency in Agricultural Marketing: Model, Methods and Progress.," *A Survey of Agricultural Economics Literature* Volume 1, ed. Lee R. Marvin (Minneapolis: University of Minnesota Press, 1977), pp.124-131.

F. Study Outline

The study proceeds with a review of relevant literature. Following this, Chapter Three reviews the economic basis of grain grading, the history of grain grading in Canada, the present Canadian grain grading system and the grading systems in other major wheat exporting countries. In Chapter Four, terminal elevators, their development and operations and agencies that affect operations are described. Chapter Five compares the handling and transportation systems which affect terminal elevator operations in Canada and other major exporting countries. A descriptive analysis of the effects which Canada's grain grading system has on the operations of Pacific Coast terminal elevators is carried out in Chapter Six. In conclusion, Chapter Seven contains a discussion of results and makes recommendations for further research.

II. Review of Related Literature

The effects of the Canadian grain grading system on the operation of terminal grain elevators has limited exposure in economic literature. However, several studies investigate subjects related to this thesis. These studies pertain to terminal elevator operations, grain grading in Canada, and the effects which the grading system has on other segments of the grain handling and transportation system. A review of these studies is presented below in sections, delineating this study's topic.

A. Terminal Elevator Studies

The studies reviewed in this section pertain to the terminal elevator operations and associated problem areas. None of the studies attempted to determine the costs of the individual terminal operations nor the costs incurred by the terminals attributable to the grain grading system. However, the studies are useful in identifying possible effects the grading system may have on terminal elevator operations. Studies related to problems at the West Coast terminals are presented first and deal primarily with problems related to operations. Following this, a study of the terminal at Churchill, Manitoba is reviewed to highlight differences in operations.

West Coast Terminal Studies

PACIFIC COAST STUDY

In 1976, the Pacific Coast Sub-Committee of the Grain Handling and Transportation Committee, Canada Grains Council produced a report concerning the export of prairie grain through the Pacific Coast.[17] However, the report was not restricted to the Pacific Coast as recommendations were made for improvements in all facets of the Western Canadian grain industry. The problems specifically related to terminal elevator operations were as follows:

1. Delays in car unloading;
2. Sequence of car unloads at Vancouver Terminals;
3. Effective working capacity of the Vancouver terminals;
4. Organization of the terminal elevator plant;
5. Grain cleaning as related to throughput; and
6. Grain segregation

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[17] Canada Grains Council, *Pacific Coast Study* (Winnipeg:C.G.C., 1976).

Statistical and descriptive analyses of the problems were presented, the type of analysis dependent on the data available.

The Committee reported that during crop years 1971/72 through 1975/76, 4690.55 hours were lost to delays in car unloading due to within-terminal causes. During crop year 1975/76, 1747.5 hours were lost to unloading delays, 37.1 percent of the loss was attributed to the railways and 62.9 percent to the terminals themselves.[18]

The second problem investigated in the study concerned the sequence of car unloads at the terminals. The study found: "The majority of adjacent cars spotted contain different grains and grades which require distinct actions within the elevator."[19] Using data obtained from the Canadian Grain Commission, covering a two day period the committee found:

> On day one 69 percent of the lots were made up of a single car of grain unlike either of its attached neighbours in the 'shunt'. In three cases individual cars represented multiple shipments. On day two over 72 percent of the shipments were made up of single cars with one car representing a multiple shipment.[20]

Due to the sequence in which the cars arrived at the elevator, the terminal operators had difficulty planning their daily operations. In addition, different grains and grades were handled differently in the terminals, so there could be no maintained effort on one grade or grain due the the way the cars arrived.

The third problem investigated by the study was the effective working capacity of the terminals. The study identified factors which affected the space utilization at the terminals. These factors included, but were not restricted to, the following:

> Space must be reserved for in-plant operations including cleaning, reclaiming, and mixing. Usable space is also affected by the number of grains and grades handled, and by the number of by-products of the processing function, each of which requires use of a separate bin. Some of the bins at a given point of time are only partially filled with a particular product.[21]

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[18] *Ibid.*, p.p. 161-162 .
[19] *Ibid.*, p.163.
[20] *Ibid.*, p.. 164. A lot is the number of adjacent cars containing grain of the same grade.
[21] *Ibid.*

The study determined that the proportion of space used in relation to the total space available in the Vancouver terminals between crop years 1971/72 and 1975/76, ranged from 46.7 percent to 64.1 percent.[22] In addition, during crop year 1975/76 the elevators were congested for 47 of the 52 weeks.[23] The tying up of space for in-plant operations as well as partially used bins reduced the effective capacity of the terminals, which in turn lowered the throughput.

The organization of the terminal plant was the fourth area of discussion in the study. This section dealt with the structure, conduct, and performance of the terminals at the West Coast. Alternative methods of increasing efficiency of the terminals in Vancouver by either increasing the competitive environment or managing all the terminals as one unit with each of the terminals specializing in certain grains were discussed.

Grain cleaning as related to throughput was the fifth problem area mentioned in the study. The major points raised related to the top two grades for red spring and durum wheat. Due to the rigid standards for these grades, the grain often must be cleaned more than once, requiring additional resources. The study suggested that increasing the tolerances for these grades would allow one-pass cleaning without jeopardizing Canada's position in the world grain trade. The study also suggested that only wheats containing less than assigned maximum dockage levels be shipped from the Prairies.

Grain segregation as it affects the terminals was also described in the report. The main points in this section dealt with the number of grades available in the Canadian system and the primary and export standards for some grains. Although no quantitative analysis was carried out, the report states: "A large number of bins are required to maintain the identity of particular lots of grain by grade."[24] As well as the grades of grain, the two top grades of red spring wheat are segregated on a protein basis which requires additional bin space. The study points out: "The numerous grain segregations required under the present grading system are not conducive to

[22] *Ibid.*, p.167.
[23] *Ibid.*, p.. 168. Congestion occurs when elevators are unable to unload cars because empty bins are unavailable. Congestion also occurs when either too much grain or the wrong kind of grain or both arrives relative to the shipments out of the port at the same time.
[24] *Ibid.*, p. 175.

efficient use of bin space. These segregations also have an adverse effect on elevator throughput."[25] The study goes on to state:

> Regardless of the merit or otherwise of having so many grades of grain defined, there appears to be little gained by having a primary standard as well as an export standard for certain grades of grain, the tolerances for the former being lesss stringent than, those for the latter. This differentiation imposes an additional burden on the terminals which must rely on the 'average' quality of the grain coming in under the primary standards to be as good or better than the export standards to prevent grade losses.[26]

The study points out that the throughput of the terminals can be increased by either more efficient use of the facilities or increasing the capacity. The report suggests that, although the latter method was being pursued at the time, there was a high cost attached. On the other hand the, report states:

> Considerable opportunity exists for expanding the throughput capacity of the existing terminals by revision of grade standards, modification of sales procedures and improved coordination between shipments from the primary elevators and requirements of the terminals.[27]

Grain Handling and Transportation Study

The 1979 report submitted by Booz-Allen & Hamilton Inc. and I.B.I. Group to the Grains Group of the Department of Industry, Trade and Commerce on Grain Transportation and Handling in Western Canada[28] contains some information on the operations of the Pacific Coast terminals. The thrust of the section concerning port operations was to determine the ability of the port of meet projected demand in future years. To accomplish this task, several areas of port operations were investigated and some recommendations were put foward.

The effects of terminal facilities on sales were studied using potential and actual throughput as as measure of efficiency. During the study year 1977/78, April was the month of greatest throughput. Using terminal operation standards of 10 shifts per week for unloading and 15 shifts for cleaning, cleaning and unloading, facilities were utilized 75 and 71 percent,[29] respectively in April.

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[25] *Ibid.* , p.176.
[26] *Ibid.*, p.176.
[27] *Ibid.*, p.178.
[28] Booz-Allen & Hamilton Inc, *Grain Transportation and Handling in Western Canada:Technical Report*. (Bethesda: 1979). (Report to Department of Industry, Trade and Commerce, Grains Group, Ottawa.)
[29] *Ibid.*, Chapt VII p. 8.

Factors limiting the utilization of the unloading and cleaning facilities were identified

> When grain storage is low, the elevator may be limited by what it can unload and by what is available to unload. When storages are full, the elevator may be limited in what it can clean and by whether ships are available for the cleaned grain which it has.[30]

Cleaning facilities were identified as the major determinant of the volume of grain, terminals could handle within a given time period. The report estimated an annual attainable throughput at the West Coast of 10.8 tonnes[31] based on the assumption of cleaners working at 76 per cent of rated capacity for 15 shifts per week.

Storage capacity was another area cited in the report which affected throughput. Effective space, turnover and buffer stocks were identified as affecting storage capacity. Drying and rail capacities were other factors noted in the study as having an effect on throughput. However, drying is only a factor in wet years and is not an operation which must be performed on all grains. Rail capacities at the time of the report were projected to be adequate until 1984/85.

The study put foward some recommendations to increase throughput at the Pacific Coast:

1. Work more shifts per week at the terminals.
2. Port supplies should be supplemented with cleaned grain from the Prairies.
3. Smoothing vessel arrivals to reduce peaks and troughs in shipping
4. Construct new terminal facilites to increase throughput.[32]

Churchill Study

The costs and problems associated with exporting grain through the Port of Churchill were studied by the Canada Grains Council in 1981.[33] The terminal at Churchill differs from other grain export terminals in that only two grains, wheat and barley, are handled. Another factor which differentiates Churchill from other terminals is the short shipping season. In relation to these two factors, the study states:

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[30] *Ibid.* Chapt VII p.7.
[31] *Ibid.* .
[32] *Ibid.*, Chapt. VII pp.14-16.
[33] Canada Grains Council, *Exporting Grain Through the Port of Churchill: A Capacity, Cost and Systems Analysis.* (Winnipeg: C.G.C, 1981).

> Over the 1975/76 to 1979/80 period, the terminal space at Churchill turned over an average of 4.8 times during its 3 month season. In comparison, over the same period the terminal capacity at Thunder Bay turned over an average of 6.2 times during its 8 1/2 month shipping season; while the facilites at Prince Rupert and Vancouver turned over 12.6 and 10.9 times, respectively, during 12 month seasons. Churchill's relatively good performance in this respect reflects both the careful scheduling and coordination by the Canadian Wheat Board, CN Rail and the National Harbours Board, and the high degree of specialization each year in handling only a limited number of grades or types of grain.[34]

A cost comparison for grain exported through Churchill, Thunder Bay and Prince Rupert was carried out in the study. To determine the terminal elevator costs, the researchers attempted to determine the operating costs for the terminals at the three ports on an economic basis. However, the data received could not be used due to "deficiencies in important fixed cost categories."[35] The terminal operating costs used were based on the tariffs set annualy by the Canadian Grain Commission. These tariffs tend to be uniform across Canada and the study states:

> The inherent drawback of using assessed tariffs in a cost study of this nature is that tariffs tend to mask important cost differences as reflected in operating characteristics of various terminals, their geographical differences and the respective operating, maintenance and capital investment practices.[36]

B. Grain Grading Studies

Two studies are reviewed in this section, one which took place prior to the revision of the *Canada Grain Act* in 1970, and one which was completed in the 1980's. The purpose of reviewing these studies is to understand the rationale behind the present grading system and the direction in which the system may proceed in the future. These studies are reviewed in chronological order.

1967 Grading Study

In 1967, M.J.Conacher completed a review of grain handling and grading in Canada for the Board of Grain Commissioners.[37] The emphasis of the study was to determine what restructuring of the grading system should take place in order to improve the system. The emphasis of the study is indicated in the following statement:

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[34] *Ibid.*, p.47.
[35] *Ibid.*, p. 125.
[36] *Ibid.*, p.126.
[37] M.J. Conacher, *A Study of Grain Handling and Grading* (Winnipeg: Board of Grain Commissioners for Canada, 1967).

It is obvious that a reduction in the number of grades of Canadian Grain would result in more efficient handling and more economical use of storage facilities in the licensed elevator system. But it is also obvious that indiscriminate elimination or consolidation of grades would mean the loss of marketing advantages which result from being able to offer a choice of several grades for each kind of grain. In restructuring the Canadian grain grades, both these considerations must be kept in mind.[38]

The study recommended that the number of statutory grades be reduced from the 226 grades present in the *Act* to 128, and that the number of commercial grades available be increased from 32 to 41.[39] The reduction in statutory grades was suggested because

The statutory grades should, preferably, encompasss only the medium to high range of quality, in each kind of grain, that is normally produced and marketed in substantial quantities. Top grades of some kinds of grain have become unrealistic in terms of the actual quantity that is produced and in terms of practical commercial handling.[40]

The reason for the proposed increase in the number of commercial grades was given in the following statement:

The lower grades for most kinds of grain should preferably be commercial rather than statutory grades. The quality of low grade grain can be quite variable, depending on the cause of degrading; for example, badly frosted grain is very different from rusted or weathered grain. The greater flexibility of commercial grades in comparison with statutory grades is a distinct advantage.[41]

Based on these criteria, the report recommended changes to the grading system for the many grains grown in Canada. Some, but not all, of the changes recommended in this study were incorporated into the *Canada Grain Act* in 1970.

Grain Council Grading Study

During the 1980's, the Grain Grading Committee of the Canada Grains Council prepared two studies of grain grading in Canada.[42] The first report, completed in 1982, covered the entire grading system with an appended report on barley grades. A second

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[38] *Ibid.*, p.3.
[39] *Ibid.*, p. ii .
[40] *Ibid.*,p. 4.
[41] *Ibid.*
[42] Canada Grains Council. *Grain Grading for Efficiency and Profit.*(Winnipeg: C.G.C, 1982); Canada Grains Council. *Wheat Grades for Canada-Maintaining Excellence* (Winnipeg:C.G.C, 1985).

report dealing specifically with wheat grades followed in 1985. The 1982 report was reviewed as the 1985 study relied on the findings of that study.

The terms of reference for the Grain Grading Committee were

> To determine economic grade structure for the principal Canadian grains, such structures segregating the individual grades on the basis of factors having economic significance in such a manner that the returns received by producers are maximized.[43]

Within the terms of reference the Committee identified several issues which dealt with the economic impact of the present grading system on the marketing of Canadian grain.

The issue of the number of grades present in the Canadian grading system was studied using two assumptions.

> 1. That the cost of segregation to the handling and transportation system was at least $2.00 per tonne.
> 2. Any single segregation if it were to be economic should contain at least 10 percent on average of the volume of the particular class of grain involved[44]

The study used data from crop years 1976/77 to 1980/81 to determine average price differentials. Using the two assumptions, each grade was analysed to determine if it was economically viable, i.e., if the price differential between the grade examined and the preceding grade was greater than $2.00 per tonne and the grade accounted for greater than 10 percent of the volume in that particular class of grain. The finding of the study was that; "the grading structure for wheat, oats and barley left something to be desired from an economic standpoint."[45] The report also indicated that a reduction in grades may provide an economic benefit to "producers and as well be beneficial to the handling and transportation system."[46]

A second issue addressed by the study concerned the prohibition of blending the top two grades of hard red spring wheat, No. 1 CWRS and No.2 CWRS. No analysis was carried out concerning this issue, but the study referred to a report produced in 1933 by H.L.Griffin which stated that at that time the blending prohibition was not required and blending should be allowed.

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[43] Canada Grains Council, *Grain Grading for Efficiency and Profit*. (Winnipeg: C.G.C., 1982), p.2.
[44] *Ibid.*, p.96.
[45] *Ibid.*, p.p. 99-100.
[46] *Ibid.*, p.106.

The existence of primary and export standards for certain grains was the third issue examined in the study. The effect of the tolerances for cleanliness of export standards was investigated by the Committee. They found that if the tolerance for "other seeds" in wheat were increased to .40 percent from .20 percent the cleaning capacity of the four Lakehead terminals studied would increase by 46.5 percent.[47] The Committee suggested that the two standards be reassessed with a view to the cost of maintaining the standards and the benefits accrued.

Moisture content was the fourth issue raised by the study. Problems with the present method of grading and pricing of grain containing excess moisture were:

1. The arrival of tough and damp grain, particularly the latter, at a terminal can seriously interfere with throughput if not carefully regulated.
2. Producers deliver grain near the maximum of the individual moisture ranges.
3. Artificially dried grain does not compact as well and gives rise to lower test weight.[48]

The report also looked at the exclusion of some grains from the system. The report suggested that grain for which no market was available should be excluded from being delivered. The unwanted grain ties up space in the handling system and thus adversely affected throughput.

Varietal licensing was also studied in the report. However, as varietal purity has no real effect on terminal elevators as yet; review of this area is not covered in this section. This study and the 1985 study make several recommendations which, if followed, could impact on the throughput of terminal elevators.

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[47] *Ibid.*

[48] *Ibid.*, p.120.

C. Handling System Studies

The effect of the grain grading system on the operational efficiency of primary elevators in Alberta was studied by *Hoar, Hawkins and Lerohl*[49] of the University of Alberta. The study determined the following:

1. A significant relationship existed between the number of grades of grain a primary elevator receives and the average cost of operating the elevator.
2. An increase in the number of grains received at an elevator reduced the average cost.
3. There was no relationship between volume of grain received and average cost, the relationship being due to turnover rather than just to volume.
4. There was a relationship between the receipts-to-capacity ratio of the elevator and cost. As throughput increased, costs per tonne were reduced.
5. The average cost decreased as the capacity of primary elevators increased.
6. There was a relationship between average cost and elevator age. Older elevators had increased cost.[50]

The study also indicated that the primary elevator system was capable of handling the present grading system as the average elevator received an average of 17.50 grades[51] per year. This number of grades was within an elevator's handling capabilities.

D. Summary

The majority of studies reviewed in this Chapter were of a descriptive nature. The Hoar, Hawkins and Lerohl study was the only study reviewed which used extensive quantitative analysis. Part of the reason for the differences between the terminal elevator studies and the primary elevator study is that while Hoar, Hawkins and Lerohl were able to

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[49] W.J.Hoar, M.H.Hawkins and M.L.Lerohl, "Effects of Domestic Grain Grades on the Operational Efficiency of Alberta Primary Elevators" *Agriculture and Forestry Bulletin*, Vol.6, No.4, (Edmonton: The University of Alberta, 1983).
[50] *Ibid.*, pp.55-56.
[51] *Ibid.* p.55.

sample approximately 150 primary elevators[52], in Alberta which belong to two companies[53] there are only seven operating terminals on the Pacific Coast. These seven elevators are operated by five companies. Therefore, the population from which a sample may be drawn for terminal elevators is far smaller than for primary elevator studies. In addition, primary elevators tend to carry out fewer operations than terminal elevators making the acquisition of cost breakdowns much easier. Due to the present method of determining tariffs for terminal elevators,[54], the costs of individual operations are not determined by the terminal operators. This problem was noted in the Churchill study.

Although the studies on the grain grading system and terminal elevators were limited in the amount of quantitative work carried out, their findings provide some insights into the problems in the system. The problems which the terminals experience are either directly related or indirectly to the system of grading. Problems directly related to the Canadian grain grading system are those such as cleaning, segregation and storage problems. Problems indirectly related to the grading system are those such as the sequence of car arrivals and utilization of terminal facilities.

Insights into problems related to grain grading were provided by both the study of Churchill's terminal and the Grain Council's 1982 grading study. These studies pointed out that throughput can be increased by limiting the number of grades and grains handled by a terminal and that there may not be an economic basis for some of the existing grades.

The studies reviewed in this Chapter provide a foundation for the thesis by providing direction for research into the interaction between the grading system and terminal elevators. In addition, the studies reveal the problems which exist in doing research into the interaction between grain grading and grain handling.

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[52] *Ibid.*, p.53.
[53] United Grain Growers and Alberta Wheat Pool.
[54] Each terminal operator submits annual cost and revenue sheets to the Canadian Grain Commission and the Commission uses these submissions to determine the next year's tariffs.

III. Grain Grading

Several methods of studying agricultural product marketing are expressed in economic literature. Of the available methods, the functional approach is used by a considerable number of authors. The functional approach breaks down the processes which occur during the marketing of products into areas of specialized activities. The three major categories of functions identified are exchange functions, physical functions and facilitating functions.[55] Standardization is one of the facilitating functions in that it is "the establishment and maintenance of uniform measurements."[56] In the case of grain, standardization involves both quality and quantity (i.e. the grain grades, and measurement in metric tonnes).

Grain grading can be defined as the "segregation of heterogeneous material into a series of grades reflecting different quality characteristics of significance to users."[57] The process of grading is important in the marketing of grain as unlike manufactured goods which are mass produced according to standards, grain quality is subject to the effects of soil, weather, and the individual producer's agronomic practices. Although the same variety of grain is grown in several areas, the resultant product is different with respect to quality factors. This heterogeneity of quality in the grain necessitates some method of communication between the buyer and seller about the characteristics of the product being exchanged. A system of grades provides this communication mechanism.

Wills states that for a grading system to be effective, it should:

1. Be accepted by the trade,
2. Provide a truly representative sample,
3. Be easy to evaluate,
4. Provide an evaluation in a short period of time,
5. Minimize the number of subjective factors to be considered,
6. Be relatively inexpensive from the standpoint of personnel, facilities and value of the sample, and
7. Measure factors that reflect the value of the product[58]

In addition to these criteria, the grading system should reflect the differences in the use of the product. Price differences for grades allow participants in the

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[55] Richard L. Kohls and Joseph N. Uhl, *Marketing of Agricultual Products* (5th ed; New York: Macmillan, 1980), p.24.
[56] *Ibid.*, p.25.
[57] Canada Grains Council, *Grain Grading for Efficiency and Profit* (Winnipeg: C.G.C., 1982), p.6.
[58] Walter J. Wills, *An Introduction to Grain Marketing* (Danville, Ilnois:The Interstate Printers & Publishers Inc., 1972), pp.35-36.

marketplace to compare within and between markets.[59]

The grading of grains also assists in increasing efficiency in marketing the product. Examples of the efficiencies obtained through grading are listed by *Shepherd and Futrell*:

> Operational Efficiency

1. Grading provides a more precise definition of the commodity and permits bargaining to settle down quickly to the basic price issues which relate to supply and demand.
2. Grading has increased specialization.
3. Grading has reduced the expense of brand advertizing.
4. The enlarged market area for both buyers and sellers which grading provides encourages more efficient movement to ultimate outlets, thus minimizing transportation costs.

Pricing Efficiency

1. Grading provides a more accurate language for price quotations. Buyers and sellers can understand each other more easily. Grading makes market news much more meaningful and enables it to be transmitted more effectively. By enlarging the area of informed decision making in the marketing process, grading makes the pricing system a more articulate means for communicating consumer preferences to producers.
2. Grading increases buying by description.
3. Grading increases the level of competition in the market. This enables the marketplace to allocate more systematically the available supplies of each kind of quality.
4. Grading helps in achieving a measure of standardization and quality control in the merchandizing process.[60]

Grading also helps in the reduction of costs within the system as the use of grades facilitates the co-mingling of grain of similar quality for transportation and storage.

Due to the heterogeneous nature of agricultural products, the co-mingling of grains into grades is a set of compromises. These compromises are necessary in order to classify the grain into categories which are useful to the buyer without placing too great a burden on the marketing system. Williams and Stout suggest some economic critera for an optimal grading system:

5. Distinct or potentially separable demand functions, based on real rather than illusory differences, exist. This means that one or more basic quality attributes are of economic importance to a significant number of consumers for all uses or for significantly large

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[59] *Ibid.*, p.36.

[60] Geoffrey S. Shepherd and Gene A. Futrell, *Marketing Farm Products* (7th ed; Ames: Iowa State University Press, 1982), pp.180-181.

volume-use categories.

6. In the absence of grades, consumers, marketing firms or both cannot readily and accurately distinguish among significantly large differences in basic quality attributes or differences in combinations of these attributes.
7. Grade standards are established which provide the most effective basis possible for the distinct and separable demand functions of consumers and other buyers. This means that:
   a. Variations in all economically important attributes can be measured precisely and all are employed as grade-determining criteria in the standards.
   b. The standards should separate units of the commodity into groups such that for each grade the within-grade variation in quality attributes, relative to the variation in that grade and each of the two possible adjacent grades, has been minimized.
   c. The standards should maximize differences among grades in the range of quality attributes which means that overlapping has been reduced to a minimum.
8. Any net reductions in cost are maximized or, alternatively, the value represented by the additional average price consumers or other buyers are willing to pay minus average (net) unit marketing costs is positive and maximized.
9. Insofar as possible, the first three criteria should be satisfied simultaneously. In addition, the system must be
   a. simply, easily, widely, and uniformly understood,
   b. fixed and unchanging in a short term sense, and at the same time, subject to change as warranted by longer-term considerations, and
   c. workable in the marketplace.[61]

Agricultural products, especially grain, are subject to differing environmental conditions. In any given year, this results in a continuum of quality characteristics. Grading, therefore, places arbitrary boundaries throughout this continuum. Any grading system, even an optimal one as suggested by Williams and Stout, has to compromise on the placement and number of these arbitrary boundaries. The objective of this compromise is to maximize the usefulness of the grades in terms of satisfying customer wants and needs as well as returns to the producer, and to minimize the cost burden on the system.

A. The History of Canadian Grain Grading

Grain grading is one part of the grain merchandising package as are price and the regularity of supply.[62] Grades provide the buyer with information concerning quality and allow him to decide if the price is consistent with that quality. The majority of grain sales

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[61] Willard F. Williams and Thomas T Stout, *Economics of the Livestock-Meat Industry* (New York: Macmillan, 1964), p.486-488.

[62] Canada Grains Council, *Grain Grading for Efficiency and Profit* (Winnipeg: C.G.C., 1982), p.16.

made domestically and internationally are wholesale arrangements. Customers include domestic grain processors, such as flour mills, feed mills, oilseed crushing plants and malting companies, and foreign buyers. Each customer has different quality requirements dependent upon the end use of the product. The dilemma, then, is how many and what quality characteristics should be included in the grading system to maximize total returns?

The first Canadian legislation concerned with grain grading and inspection was passed in 1863.[63] This legislation borrowed directly from the grading system established by the Chicago Board of Trade, but was defined for the whole of the Province of Canada. This legislation dealt with the grains grown in Ontario and Quebec as there was minimal grain production on the Prairies. Following Confederation in 1867, the Dominion parliament extended the legislation to cover the whole of the new Dominion in 1873. In 1874, the act was revised to include some minor changes concerning wheat. These pieces of legislation, like their forerunner, borrowed heavily from legislation in the U.S., particularly the Illinios Statute of 1871.[64]

Standards for Western Canadian grain were established in 1884, when Captain William Clarke was named inspector for the newly established Inspection District of Winnipeg. At this time it was stated in the House of Commons that Canadian standards would be higher than standards in the U.S. because Canadian wheat was "better".

The *General Inspection Act* of 1886 was the first piece of legislation that included grade definitions for western wheat. Grades for other grains grown in Western Canada were the same as those in the east. A Board of Examiners which was responsible for selecting and approving standard samples was set up in Toronto under the newly passed *General Inspection Act*. In 1889, as a result of pressure from grain merchants in Winnipeg for a western Board of Examiners, the *Act* was amended to include a Board consisting of persons from west of Port Arthur, Ontario. The Act was amended again in 1891 to include commercial grades for grain which did not meet the statuatory standards.[65]

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[63] G.N.Irvine *The History and Evolution of the Western Canadian Wheat Grading and Handling System* (Winnipeg: Canadian Grain Commission, 1984), p.8 .

[64] *Ibid.*, p.9.

[65] Statutory standards for graom were established by the 1886 *General Inspection Act*. These standards, therefore, were defined by law. Problems arose, however, with grain which did not meet these legally established standards, as there was no legal basis for standards by which they could be graded and sold.

The *Manitoba Grain Act* of 1900, the forerunner of the *Canada Grain Act*, was passed as a result of the Senkler Commission report. The major impact of the *Act* on grain grading concerned the regulations which applied to wheat grown in the west.

> The legislation also forbade the mixing of different grades in public elevators and the use of special bins for segregation of parcels which might be of especially high quality. This was a definitive move toward maintaining the "quality enhancement" that resulted from blending numerous parcels of the same grade. A further regulation stated that any wheat shipped from any terminal elevator would be inspected only at a lower grade if it showed evidence of being below the average quality of the grade in the bins of public elevators(where no mixing was allowed). This was the origin of what became know as the Export Standard, in the 1929 revision of the *Canada Grain Act*.[66]

One other significant change which arose from the *Act* was that inpectors became salaried government employees rather than being paid from inspection fees.

The *Canada Grain Act*, which was passed in 1912 as a result of recommendations of the 1908 Royal Commission report,[67] amalgamated several acts which dealt with grain grading, inspection and handling. One important feature of the *Act* was the authorization of a Board of Grain Commissioners for Canada, the forerunner of the Canadian Grain Commission. It was the Board of Grain Commissioners who recommended the construction of federally-owned terminal elevators. The *Canada Grain Act* was amended in 1925 to provide for the organization of the wheat pools and to allow a western route for grain exports. In 1929, further amendments allowed the Board of Grain Commissioners to move to Winnipeg, and set export standards.

A new *Canada Grain Act* was written in 1930 which gave the federal government the power to control grain handling and trading. The *Act* also provided the Board of Grain Commissioners with more power to regulate the grain industry, established patent rights on use of grade names and allowed the Board to have a laboratory to carry out grain research. This *Act* remained in effect until 1971 when the present *Canada Grain Act* came into force.[68]

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[66] G.N. Irvine, *The History and Evolution of the Western Canadian Wheat Grading and Handling System* (Winnipeg: Canadian Grain Commission, 1984), p.47.

[67] *Ibid.*, p.51.

[68] See *Ibid.* for a more complete discussion of grain grading in Western Canada from the 1850's to 1982.

B. Grain Grading in Canada

Grain, a botanical term, refers specifically to the seeds of cereal plants, which are by definition grasses. However, in common usage grain refers to the seeds of cereal plants plus seeds of leguminous plants (peas and beans) and oilseed plants (canola, flaxseed and mustard)[69] which are non-grassy species. This seemingly contradictory term is used solely for convenience as the seeds of all three types of plants utilize the same physical facilities for handling and transportation.

The *Canada Grain Act* makes this convenience official by defining grain as 'any seed named in Schedule 1 or designated by regulation as grain for the purposes the *Act*.'[70] Schedule 1 is the part of the *Act* which sets out the statutory grades of grain and is only subject to amendment by Order in Council following notification of Parlament. Grain, therefore, is any seed named in Shedule 1 or as defined by Order in Council. Schedule 1 of the *Canada Grain Act* separates grades applicable to the Eastern and Western Divisions.[71]

The purpose of grain grading is to separate grain into categories dependent upon qualitative factors related to potential end use of the product. The Canadian grain grading system has been designed to accomplish this task. The quality characteristics used in grading-- 1) test weight, 2) varietal purity, 3) vitreousness, 4) soundness, 5) foreign material, 6) dockage,[72] 7) moisture content,[73] and 8) protein content,-- vary depending upon the particular grain being graded. Some of these characteristics can be measure objectively (test weight, moisture content, protein content, foreign material and dockage) whereas varietal purity, soundness and vitreousness must be measured subjectively by visual inspection. The use of visual measures requires that the grain inspectors be well

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[69] The exception is the soybean which is a leguminous plant but is classed as an oilseed.

[70] Canada Grain Act, *Stautes of Canada* , 1970 c.7 s.2(16).

[71] Western grain is any grain produced in all of Canada which is west of the meridian that passed through the eastern boudary of Thunder Bay Ontàrio.

[72] Dockage is foreign material which can be removed from the grain through mechanical cleaning. Dockage is an important factor at the primary elevator in that a deduction in price is made based on the percent of foreign material present in the sample. However, dockage does not affect the final grade for the grain.

[73] Moisture in grain content can be altered by mechanical drying processes. Moisture content is a factor which is applied to grades rather than a grading factor. For example, a certain grain might be graded No. 1 damp , but following drying, will become a No.1. There are five levels of moisture content in the system. The absolute level is dependent upon the type of grain.

trained to ensure consistency.

Four classes of grades of Canadian grain and grain screenings are established under the *Canada Grain Act*. They are:

1. Class I Grades (Statutory),
2. Class II Grades (Special Grades),
3. Class III Grades (Off Grades), and
4. Class IV Grades (Screenings).

Class I grades, the statutory grades, are the most commonly used grades and segregate the quality of various types of grain.

Class II grades, established under the Canada Grain Regulatons, include experimental grades for new types of grain and special grades not included in the statutory grades. Special grades are established when otherwise sound grain affected by rust or drought is shrunken or lightweight.

The Class III, off grades, are grades that due to condition or admixture,[74] cannot be included in the statutory grades. These grades include tough or damp grades, and grains rejected due to stones, fireblight, ergot, heating, drying and admixture.

Class IV grades are the grades of screening and dockage which are recovered from the cleaning of grain and also include pellets made from collected grain dust, small seeds, hulls and other grain refuse.

Within the four classes of grades, there were in 1979 "36 identifiable grains and grain byproducts" and 159 separately defined grades[75] under the *Canada Grain Act*.[76] Within the grading structure there exist several qualifiers which increase the number of grades so that there are "upwards of a thousand different grades of Canadian grain."[77]. Wilson further states that:

> In the course of a normal crop year, the Inspection Division of the Canadian Grain Commission issues grade certificates identifying as many as 800 different grades of grain. Yet each one of them is different, and each

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[74] Admixture is when more that one species of grain is mixed together. For example wheat and barley together in one parcel.

[75] Charle F. Wilson, *Grain Marketing in Canada* (Winnipeg: Canadian International Grains Institute, 1979), p.17.

[76] The number of grains, grain byproducts and defined grades may change with new experimental grades and changes to the *Canada Grain Act*.

[77] Charles F. Wilson,*Grain Marketing in Canada* (Winnipeg: Canadian International Grains Institute, 1979), p.17.

commands a market price related to its respective quality.[78]

The statutory grades are established by Order of the Governor in Council, on the recommendation of the Canadian Grain Commission. The Canadian Grain Commission receives recommendations on grade changes from the Western and Eastern Grain Standards Committees. The composition of these Standards Committees are as follows:

> The Western Grains Standards Committee is composed of: a commissioner, grain inspector and chemist from the Canadian Grain Commission; the chairman of the Western Division Grain Appeal Tribunal; two persons nominated by the Deputy Minister of Agriculture Canada; one person nominated by the Canadian Wheat Board; two grain processors; two grain exporters; twelve grain producers and not more than three other persons selected by the Commission.
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> The Eastern Grain Standards Committee is composed of: a commissioner, grain inspector and chemist from the Canadian Grain Commission; one person nominated by the Deputy Minister of Agriculture Canada; four grain processors and/or exporters; four grain producers; and not more than three other persons selected by the Commission.[79]

The non-statutory grades (Classes II,III,IV) are established by the Canadian Grain Commission and do not require an Order of the Governor in Council.

Due to the use of visual factors in grading, standard samples are prepared annually for all the statutory grades and special grades the Canadian Grain Commission has established for that year. The Inspection Division of the Canadian Grain Commission prepares the standard samples and submits them to the Grain Standards Committees for review. The Grain Standards Committees then recommend the standards for the grades to the Canadian Grain Commission for approval. The standard samples which are approved by the Canadian Grain Commission are that year's official standard samples. The grain which is used in the standard samples is collected at primary and terminal elevators and represents a cross-section of the production areas.

The Canadian grading system requires that two types of standard samples be prepared each year, primary standard samples and export standard samples. Primary standard samples are prepared for the statutory grades in Schedule 1 and other grades required by the Canadian Grain Commission. The primary standard samples represent the minimum quality for each grade and are used for domestic grading. Export standard

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[78] *Ibid.*, pp.17-18.

[79] Canadian International Grains Institute, *Grain & Oilseeds: Handling, Marketing, Processing* (3rd. ed; Winnipeg: C.I.G.I., 1982), p.248.

samples are prepared for grains that the Canadian Grain Commission feels are destined for export including all grades of hard red spring wheat and amber durum wheat. The reason for export standards is to guarantee the buyer receipt of average rather than minimum quality in the grade. Both primary and export standard samples contain grain from the old and new crop years as grain from the old year crop is also sold in the new year.

Quality control is maintained by the Inspection Division of the Canadian Grain Commission. The Inspection Division provides official inspections at all terminal and transfer elevators that ship Western Canadian grain directly for export. Inspection is also carried out at inland terminals. Official Inspection can only be carried out by grain inspectors where they supervise the sampling.[80] Samples which are sent for inspection by individuals can be officially inspected, but the official grade applies only to the sample, not to the load of grain from which the sample was taken.

Grain delivered to primary elevators is purchased under an official grade name. The grade is assigned by the elevator manager with the agreement of the producer. In the case of a dispute a sample can be fowarded to the Canadian Grain Commission and a process of resolving the dispute is carried out.[81] Grain from primary elevators is fowarded to process or terminal elevators. Inspection of grain arriving at the process elevators is optional except in the case of specially binned grain. All grain arriving at the terminal elevators is officialy inspected and weighed and all grain discharged by terminal elevators is inspected.

C. Wheat Grading in the Major Exporting Countries

The major wheat exporting countries have all developed grain grading systems for the purpose of facilitating communication between the buyer and the seller. The evolution of grading systems has differed between countries as internal conditions regarding production and marketing differ.

Environmental conditions affect the type of grains produced in different countries. However,an export grain common to the United States (U.S.), Australia, Argentina, the

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[80] Official sampling of grain by canadian Grain Commission Inspectors occurs only at terminal elevators and tranfer elevators which expot Western Canadian grain directly.

[81] For a discription of the process of solving disputes at primary elevators see: *Ibid*.

European Economic Community (E.E.C.), and Canada is wheat. For purposes of comparison with Canada, the wheat grading systems of these exporting countries are briefly described.

The Wheat Grading System in Canada

The *Canada Grain Act* provides for five classes of wheat in Western Canada,--Red Spring, Soft White Spring, Red Winter, Amber Durum, and Utility. The classes separate the wheats by type and the only category into which all wheats may fall is Canada Feed Wheat. Within each of these classes there are between 2 (Utility) and 5 (Amber Durum) statutory grades. Grades of wheat in the various classes are determined by various grading factors such as variety, degree of soundness, vitreousness, foreign material, wheats of other classes and non-prescribed varieties, sprouted wheat, diseases and other factors. For each grading factor either maximum or minimum limits are prescribed for every grade. Exceeding the maximum or failing to reach the minimum requirements causes the wheat to be downgraded.

Wheat which cannot be graded into one of the statutory grades may be graded either as Canada Feed or as one of the Class III offgrades.

The Wheat Grading System in the United States

The first grading and inspection system was established in the U.S. in 1858 by the Chicago Board of Trade.[82] The *United States Grain Standards Act*, passed in 1917 by the U.S. Congress, was the first federal legislation dealing with the inspection and grading of grain. The *Act* was amended several times, and in 1976, an amendment established the Federal Grain Inspection Service (F.G.I.S.).

> The principal purpose of F.G.I.S. is to facilitate the marketing of grain by providing traders with inspection and weighing information. To accomplish this, F.G.I.S.
> 1. Maintains official standards,
> 2. Promotes the uniform application of the standards by official inspection personnel, and
> 3. Offers weighing services to the domestic grain market and regulates the weighing and weight certification of grain shipped at export [83]

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[82] G. N. Irvine, *The History and Evolution of the Western Canadian Wheat Grading and Handling System*, (Winnipeg: C.G.C., 1882), p.12.
[83] K.A.Gilles,"Quality Control for United States Grain Exports" paper presented to Eighteenth International Grain Industry Course, Winnipeg, Manitoba, October

Grain is inspected by the F.G.I.S. under two U.S. statutes, the *United States Grain Standards Act* and the *Agricultural Marketing Act*.

The *United States Grain Standards Act* "requires the inspection and weighing of most export grain and provides for voluntary inspection and weighing of domestic grain."[84] Grain inspection may be done by either federal grain inspectors or state and private inspectors who are licenced and supervised by the F.G.I.S.. In 1983, employees of eight states [85] were delegated to provide inspection and weighing services. However, due to cost-cutting measures, more states are being delegated to provide these services.[86]

The *U.S. Grain Standards Act* lists 7 classes and 13 subclasses of wheat. Within these classes and subclasses there are six grades available based on quality factors. Seven special grades reflecting damage are also available. These grades and special grades apply to all officially inspected wheat, including wheat which is placed under the U.S. government loan program.

The Wheat Grading System in Australia

The unique climatic and political conditions in Australia have influenced the system of grain grading. Due to soil fertility and annual rainfall, grain production takes place in areas near the east south and west coasts. Grain grades differ among states due to climatic conditions but within each state quality differences among grains are limited. This, combined with the development of intrastate rather than interstate transportation systems and state-owned and operated handling facilities, has introduced a fair degree of autonomy in grain marketing for each state.

The Australian Wheat Board (A.W.B.) has statutory authority over all wheat sold off-farm. All other grains come under state control. Under the A.W.B., the Bulk Handling Authority (B.H.A.) in each state acts as the licenced receiver of wheat. In the case of disputes over grading between the B.H.A. and the producer, the A.W.B. arbitrates and its decision is final.

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[83](cont'd) 4, 1983 (Mimeograph).
[84] *Ibid*.
[85] *Ibid*.
[86] Personal Communication, Dan Raner, Continental Grain Inc., Tacoma, Washington, June 1984.

The Australian system of wheat grading has a formalized structure but has not been made statutory. Six classes of wheat are identified by the grading system with grade segregations and protein segregations in some classes. As only white wheat varieties are grown in Austalia, the differences between classe are based on varietal type and protein levels. The Standard White Wheat Class is used as the standard for comparison for other classes of wheat.

The producer, on delivering his wheat to a B.H.A. facility is required to submit a declaration of the variety of wheat. State inspectors grade and weigh the wheat when it is delivered and the producer is paid on this basis. Grain which is delivered to the B.H.A. facilities must be clean as these facilities have limited capacity to clean grain. Nonrecommended varieties of wheat arriving at the handling points are subject to discounts imposed by the A.W.B. under the authority of the *Wheat Industry Stabilizaton Act*.[87]

The grades assigned to wheat upon delivery by the producer are not necessarily the same as the grades at which the grain is sold. Blending of various grades and classes of wheat at export facilities ensures customer requirements are fulfilled.

The Wheat Grading System in Argentina

Argentina's system of grain grading is supervised by the National Grain Board. Grading at elevators is done by private grading firms which are licenced and monitored by the Board. Samples of grain arriving at the terminals for export are graded by either the exchanges,[88] which represent all participants in the grain trade, or at the terminal. The choice of location for grading is at the request of the customer. Export shipments are inspected by the National Grain Board to ensure the weight and quality of the grain.

The grade standards in Argentina are to classify grains "emphasizing their particular characteristics, and to insure homogeneous qualities obtained from that classification."[89] The characteristics used in grade determination are: "the proportion of the grain which is

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[87] Canada Grains Council, *Grain Grading for Efficiency and Profit* (Winnipeg: C.G.C., 1982), p.27.

[88] Argentina uses a system of grain exchanges, located in major centres. All facets of the grain industry are represented on these exchanges and it is at the exchanges that grain business takes place.

[89] Guillermo D'Andrea Mohr, "Argentina's Grain Industry" paper presented to Eleventh International Grain Industry Course, Winnipeg, Manitoba, May 31, 1979.(Mimeograph).

damaged in harvesting or due to weather; the presence of impurities; and test weight; all being directly related to end use value of the grain. ... Furthermore, the grain must be free from live insects and any other factors having a deleterious effect on quality."[90] The grade standards are the same through the whole system. Standards are maintained by the use of standard samples which are produced by the National Grain Board from samples received from throughout the system.

There are five grades for wheat, but no classes, in the Argentine system. Wheat can be upgraded through cleaning, drying and blending. Upgrading takes place following producer delivery and is part of Argentina's program to satisfy customer requirements and increase exports. Argentina also has a system of producer declarations to ensure varietal control of wheats exported.

The Wheat Grading System in the E.E.C.

The E.E.C. has progressed from being a net importer of wheat to a net exporter since the introduction of the Common Agricultural Policy (C.A.P.) in 1962. Within the E.E.C., France is the largest producer and exporter of grain. Therefore, grain grading is more highly developed in France than in the other E.E.C. countries.

The Office National Interprofessional des Cereales (O.N.I.C.)[91] in the Ministry of Agriculture is the agency which regulates cereal grains in France. O.N.I.C. is reponsible for quality definiton, the regulation of new varieties, the licencing of buyer and storage facilities and the regulation of the marketing channels.

Under the French system, licenced buyers called "Collecteurs" are the only purchasers of a producer's wheat. Collecteurs are required to meet standards concerning storage capacity, grain handling capability and conditioning facilities. As on-farm storage is in short supply, most wheat is sold off the farm during the harvest.

The grading system developed by O.N.I.C. has three classes of wheat--Soft Red Winter, White and Durum. Within the Soft Red Winter and White classes, there are four classes and two grades. Five grades and no subclasses are utilized for durum wheat. The E.E.C requires that Durum wheat must be free from odors and live pests, of 'Fair

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[90] Canada Grains Council, *Grain Grading for Efficiency and Profit* (Winnipeg: C.G.C., 1982), p.39.
[91] *Ibid.*, p.43.

Average Quality', of natural colour and "vitreous with a translucent and horny cross section."[92] Other factors include specifications for test weight, moisture content, foreign material and damaged and broken kernels. The O.N.I.C. is at present working to upgrade the system.

D. Summary

Grain grading provides a method of communication between the buyer and the seller about the characteristics of the grain which is being exchanged. Each of the grain exporting nations has developed a grain grading system which provides for this communication. However, the segregation of grain into grades should be based on economic criteria which reflects both the supply and demand of particular quality characteristics. In addition, the cost of segregation into grades should not exceed the benefit achieved by segregation, otherwise there is no economic return from grading.

Grain grading in Canada has developed over the past century into a complex system of statutory and non-statutory grades. The emphasis of grading in Canada appears to be on the segregation of grains by as many factors as possible to gain the greatest potential price. The potential cost of all these segregations does not seem to be a criteria which tempers the plethora of grades available for Canadian grains. Additionally, the Canadian grading system relies on both objective and subjective grading factors which can lead to differences in opinions about the grade of a grain.

Other exporting nations have grain grading systems which are less regulated and developed than the Canadian system. The United States, while appearing to have more grades for wheat, actually has fewer potential segregations for each type although there are more types of wheat grown in the U.S. than in Canada. The other countries also have fewer potential segregations for export wheat than exist in the Canadian system. In addition, Canada is the only country which maintains an official grading system which has two standards, one at the primary level and one at the export level.

The Canadian grain grading system is respected throughout the world for the quality control of exported grains. This is evidenced by the movement of some countries,

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[92] A. A. Macdonald, "Wheat Grading Systems of Major Exporting Countries" paperpresented to Nineteenth International Grain Industry Course, Winnipeg, May 30, 1984 (Mimeograph).

particularly the U.S., towards the development of a grading system similar to Canada's. However, other exporters are selling their wheat in the world market without the high standards which are maintained by Canada, albeit at a lower price for wheat of comparable end use. This raises the question: Is the Canadian grain grading system with its high quality control and multitude of segregations actually producing a net benefit or a net cost for Prairie grain producers?

IV. Terminal Elevator Operations

Terminal elevators are an integral part of the Western Canadian grain handling and transportation system. The functions of terminal elevators are defined in the *Canada Grain Act* as "the receiving of grain upon or after the official inspection and official weighing of the grain and the cleaning, storing and treating of the grain before it is moved foward."[93] Filling this definition are 22 elevators[94] elevators licensed by the Canadian Grain Commission as terminal elevators. Two[95] of the 22 licensed terminals are inland terminals in that they are not located on water routes. Of the remaining 20, 12 are located at Thunder Bay, Ontario, 1 at Churchill, Manitoba and 7 on the Pacific Coast of Canada, 5 at Vancouver and 2 at Prince Rupert, British Columbia.

The discussion of terminal elevators in this Chapter commences with a review of the history of terminal elevators in Canada. Following is a review of terminal operations, the organizations involved and the interaction between terminal operations and other participants in the grain handling and transportation system.

A. Terminal Elevators 1884-1984

Prior to the completion of the Canadian Pacific Railway (C.P.R.) line from Port Arthur,[96] Ontario to Winnipeg, Manitoba, shipments of grain from Western Canada to Eastern Canada were required to travel through the U.S. The first recorded shipment of wheat to travel through the U.S. from Manitoba to Ontario occurred in 1876 when R.C. Briggs of Steele, Briggs Seed Company purchased 857 bushels of seed wheat. The first export shipments of wheat from Western Canada in 1878 and 1879 were also transported via the U.S. enroute to Great Britian. In 1884, following the completion of the C.P.R. line from Port Arthur to Winnipeg, the first grain to travel an all-Canadian route was exported.[97]

Construction of the first Canadian grain terminal elevator at Port Arthur with a

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[93] Canada Grain Act, *Statutes of Canada* 1970, c.7, s.2 (48).
[94] Canadian Grain Commission, *Grain Elevators in Canada: Crop Year 1983-84* (Ottawa: Supply and Services, 1984), p.XVI.
[95] These elevators are located in Saskatoon and Moose Jaw, Saskatchewan.
[96] The cities of Port Arthur and Fort William, Ontario are now known as Thunder Bay, Ontario.
[97] Vernon C. Fowke, *The National Policy and the Wheat Economy* (Toronto: University of Toronto Press, 1957), p.105.

storage capacity of 9,500 tonnes was completed by the C.P.R. in 1884.[98] The C.P.R. built four additional terminals between 1884 and 1902 and until 1904 was the sole operator of terminals at the Lakehead. In 1904, the Ogilvie Flour Milling Company and the Empire Elevator Company each constructed terminals at the Lakehead thus breaking C.P.R.'s monopoly on terminals. The increase in terminal numbers continued with the Canadian Northern Railway's completion of a terminal at the Lakehead in 1906. By 1910, 15 terminals were in operation at Port Arthur-Fort William with a total storage capacity of 70,000 tonnes.[99]

Completion of the C.P.R. to Vancouver in 1885 failed to spark terminal construction on the Pacific Coast. Although there were some shipments of wheat made in the early 1900's, construction of the first terminal wasn't completed until 1916. A facility with a storage capacity of 34,500 tonnes[100], was constructed by the federal government in response to farmer demands. An annex was added to the facility in 1923 and a second elevator was constructed in 1924.[101] The annex was added to in the 1930's, raising the total storage capacity of this federally run complex to 199,150 tonnes (7,111,500 bu.).[102]

Other terminal elevators constructed by the federal government in British Columbia included a 46,220 tonne terminal in 1924 at Ballantyne Pier in Vancouver. In 1928, additional terminals were completed at New Westminster with a storage capacity of 20,400 tonnes and a 17,500 tonne facility on the south shore of Burrard Inlet.

Federal government construction of terminals during the 1920's was not resticted to Vancouver. A 34,019 tonne capacity terminal was built at Prince Rupert in 1925. Five inland terminals, at Edmonton, Calgary, Lethbridge, Moose Jaw and Saskatoon, as well a 68,000 tonne terminal at Churchill, Manitoba were also constructed between 1925 and 1930.

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[98] Canadian International Grains Institute, *Grains and Oilseeds: Handling, Marketing, Processing* (3rd. ed; Winnipeg: C.I.G.I., 1982), p.111.
[99] *Ibid.*, p.112.
[100] *Ibid.*, p.114.
[101] This elevator complex is still in operation, known now as Pacific Elevators Limited(P.E.L.). P.E.L. is owned by the three Prairie wheat pools with Alberta Wheat Pool owning 60 percent, Saskatchewan Wheat Pool owning 30 percent and Manitoba Pool Elevators, 10 percent. P.E.L. is managed by Alberta Wheat Pool.
[102] For consistency, storage capacities are stated in tonnes. Conversion from bushels to tonnes is accomplished using the factor 37.644 bushels per tonne. This is the wheat equivalent tonne.

Terminal elevator acquisition at Vancouver during the 1920's was not limited to the federal government. In 1925, an elevator constructed by the government, but leased to Burrard Elevator Company was completed. The 15,500 tonnes facility was operated by United Grain Growers, who owned controlling interest in the Burrard Elevator Company.

Three other privately owned terminal elevators were completed on the West Coast in 1928. Victoria Elevator Limited, the only terminal on Vancouver Island, had a storage capacity of 29,120 tonnes. The other two terminals, Burrard Terminals Limited on the north shore of Burrard Inlet and Alberta Wheat Pool had storage capacities of 42,020 and 56,020 tonnes respectively. The A.W.P. facility was advertized by the Pool as "the 'Mammoth of the Seven Seas' not only being the largest in the port of Vancouver but also topping in size all seaport terminals anywhere in the world."[103]

During the construction period on the West Coast, terminal facilities at Port Arthur-Fort William continued to increase. By 1930, there were 26 terminal elevators with a total 2.30 million tonnes storage capacity.[104] Since the 1930's, the absolute numbers of terminal elevators has declined. As compared to the 26 cited at the Lakehead in 1930, there are now only 12 terminals in operation. The three Inland Terminals located in Alberta, while still in operation, have been downgraded to primary elevator status. Of the terminals built on the Pacific Coast during the 15 year period 1916-1931, 4 are still in operation--A.W.P., Pacific Elevators Limited (P.E.L.), the Burrard Elevator Company (now known as United Grain Growers) and the Prince Rupert terminal elevator.

The four terminal elevators still operating on the Pacific Coast have undergone renovations and additional construction to bring them up to modern standards.[105] The A.W.P. terminal has been expanded and modernized several times. In 1956, additional storage and workhouse area was added. Following this, renovations were made to other facilities at the plant, including the installation of hopper car pits. In 1979, a new annex was completed with a storage capacity of 76,000 tonnes. This facility, the largest on the Pacific Coast, has a licensed capacity of 282,830 tonnes and is continually being updated.

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[103] Leonard D. Nesbitt, *Tides in the West* (Saskatoon: Modern Press, 1962), pp.112-113.

[104] C.I.G.I. *Grains and Oilseeds: Handling, Marketing, Processing* (3rd. ed; Winnipeg: C.I.G.I., 1982), p.112.

[105] The Burrard Terminals Limited elevator was severely damaged by an explosion and fire in 1975. The complex was rebuilt and reopened in 1979 by Pioneer Grain Company Limited.

In June 1984, A.W.P. announced that $80.0 million would be spent over the next few years to upgrade both A.W.P.'s terminal and P.E.L. which is managed by A.W.P.

The A.W.P. terminal is located on the C.P.R. tracks while P.E.L. is located on both C.P.R. and Canadian National (C.N.) tracks. The second largest terminal at Vancouver is the Saskatchewan Wheat Pool (S.W.P.) terminal on the north shore of Burrard Inlet. The facility was completed in 1968 and has a licensed capacity of 237,240 tonnes. This facility is located on the C.N. track. Of the other West Coast terminals, P.E.L. has a licensed capacity of 199,150 tonnes, U.G.G. 102,070 tonnes and Pioneer Grain Terminal Limited 108 000 tonnes. Both Pioneer Grain and U.G.G. are positioned on C.N. tracks. The old Prince Rupert Grain Limited terminal was upgraded in 1970 by the addition of a new 28,000 tonne annex, cleaning and shipping facilities. Additional renovations were made in 1975. The terminal now has a licensed capacity of 63,010 tonnes.

Completion of the terminal on Ridley Island in 1984 by Prince Rupert Grain Limited, a consortium of grain companies, with a licensed capacity of 209,510 tonnes and the rebuilding of the Burrard Terminal, completed in 1979, has increased the number of operating terminals on the West Coast to seven.[106]

B. Pacific Coast Terminal Elevator Operations

The major functions of terminal elevators are to receive, clean, store and treat grain before it is moved foward. These functions are performed either prior to the official grading and weighing or following official inspections. The performance of these primary functions and some secondary functions provides the source of revenue to the terminal operator. Following is a description of the operations which occur at terminal elevators on the West Coast.

Receiving

Most grain arrives at the Vancouver terminal elevators via one of the two major Canadian railways. Grain cars are shunted from one of the railway marshalling yards outside of Vancouver to the terminals located on Burrard Inlet. The cars are spotted on

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[106] All licensed capacities for terminal elevators on the Pacific Coast were obtained from: Canadian Grain Commission, *Grain Elevators in Canada: Crop Year 1984-85.* (Ottawa: Supply and Services, 1984), p. XIV.

service trackage adjacent to the terminals.[107] From this service trackage, the grain cars are moved by either a shunting engine or a cable carhaul(winch) into the trackshed. The trackshed is a covered area of track where grain cars are unloaded. The number of tracks in the trackshed varies between one and three depending upon the terminal. Once in the trackshed the hopper car is moved into position over one of the receiving pits. Box cars are positioned at the box car dumper as box cars require a special machine to remove the grain.[108] Once the car is positioned over the receiving pit, the seal placed on the car at the originating primary elevator is removed and the bottom doors on the car are opened using a hydraulic car door opener. The grain runs out of the car through a large screen into the receiving pit. The screen removes large foreign objects such as pieces of wood and cardboard from the grain. Following unloading, the empty car is removed from the trackshed and is run out to service trackage to await pickup and eventual return to the Prairies.

The receiving pits, located below the tracks in the trackshed, are V-shaped with a door at the bottom. Following the emptying of the car the door on the receiving pit is opened hydraulically and the grain falls onto a conveyor belt. The sloping sides of the V-shaped pit facilitate the flow of grain onto the conveyor. The conveyor moves the grain from the trackshed to the receiving leg located in the workhouse.[109] As the grain is moving on the conveyor, it passes under a large electro-magnet that removes "tramp" metal from the grain. The removal of tramp metal is necessary as its presence may damage equipment. The grain falls off the conveyor into a boot at the bottom of the receiving leg.

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[107] The location of the service trackage to the railway depends upon the terminal. Terminals such as A.W.P., located along the waterfront and parallel to the rail line, have service trackage which is parallel to the rail line. Terminals such as P.E.L. and U.G.G. are perpendicular to the waterfront and the railway and have service trackage which is perpendicular to the rail line. The difference in the configurations of the terminals is due to the availability and cost of waterfront space. Terminals perpendicular to the waterfront utilize less of the costly waterfront space. The disadvantage of this configuration is there is limited room for expansion of service trackage.

[108] Box car dumpers may differ, but, in general, clamps are attached to the front and rear of the car to hold the car. A hydraulic ram punches in the cardboard coopered doors to allow the grain to flow out and the car is tilted in various directions to ensure the removal of all the grain from the car into the pit below. The operation takes between five and eight minutes to unload the car. With the reduction in the number of box cars in the grain service fleet, many of the box car dumpers are being replaced with hopper car pits.

[109] The workhouse is that part of the elevator where most of the operations take place. All the legs, cleaners, scales and offices are located in the workhouse. Due the height of the legs, the workhouse is the tallest part of the terminal.

The receiving leg, an endless vertical conveyor with "buckets" attached, picks the grain up from the boot and moves it upward to a scale garner.[110] As the buckets on the conveyor pass over the top of the leg, the grain falls out into the scale garner. The grain is held in the garner until all the grain from the car has been elevated. Once the complete carload has been elevated into the scale garner, the grain is discharged into the scale for official weighing (see Figure IV-1).

Sampling for official inspection takes place as the grain enters the receiving leg. An automatic sampling device[111] scoops of grain from throughout the carload. These samples are conveyed pneumatically to the Canadian Grain Commission Inspection Office in the terminal where the samples are collected and become the official sample for the assessment of that particular carload of grain.

The weighing of the grain in the scale is conducted by a scale operator from the terminal supervised by a weighman from the Canadian Grain Commission. Automatic electronic scales have replaced manually-operated lever scales at the majority of the terminals. The electronic scales have decreased the amount of time and labour required in the weighing operation, thus increasing the efficiency. The scales are inspected and tested twice a year by the Weighing Division to ensure accuracy. The weight of the grain is officially recorded as the amount of grain received into the terminal.

The receiving pit, receiving leg, scale garner and scale operate as one unit. By regulation, no outlet from the receiving leg other than the scale garner and scale is allowed. This ensures that all the grain received into the terminal is officially weighed and prevents any form of skimming by the terminals.[112]

Official Grading and Weighing

Although official inspection of the grain received and discharged by terminal elevators is carried out by employees of the Canadian Grain Commission and is not part of the terminal operations *per se*, these functions affect overall terminal operations and,

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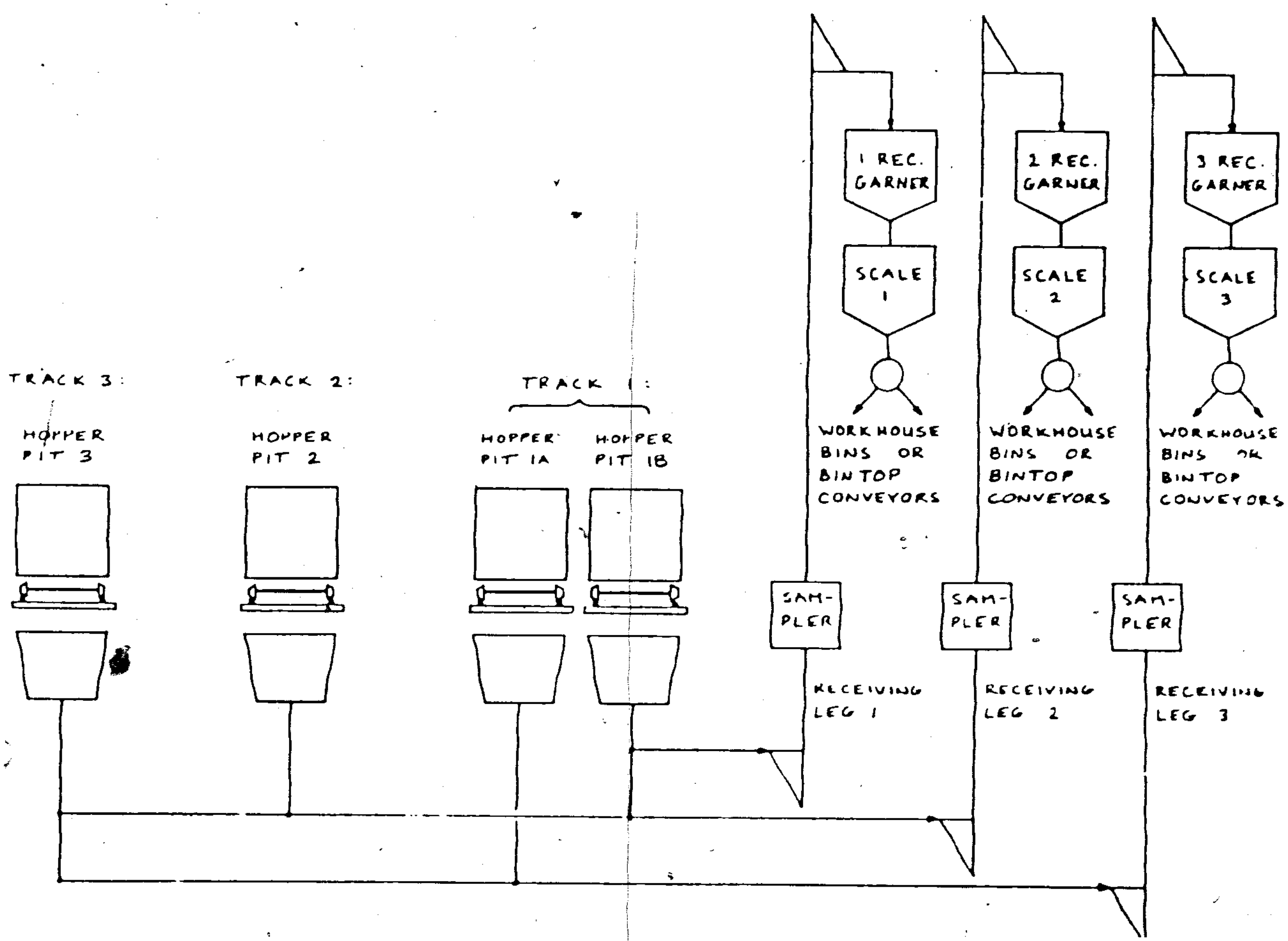
[110] A garner is a suspended storage compartment. A scale garner is a garner which empties into the scale.

[111] Automatic samplers are maintained and operated by the Canadian Grain Commission's Inspection Division.

[112] Skimming occurs when grain is removed prior to official weighing so that the elevator receives more grain than it is reponsible for as determined by the official weights.

Figure IV-1 Receiving System Schematic Diagram.



Source: Swan - Wooster Engineering Co. Ltd., Alberta Wheat Pool Vancouver Terminal Simulation Analysis.

thus, are described in this section.

In the grading process, a sample is taken from the sample removed from the grain by the automatic sampler. The size of the sample used in grading depends upon the grain being graded and the quality factor being tested. Specification of the size of the sample is dependent on the particular "Basis for Determination" listed in the *Official Grain Grading Guide*. The Basis for Determination indicates the range of sample sizes usable for that factor. For example, in wheat, the Basis of Determination for "Foreign Material Excluding Cereal Grain" is " A representative portion of approximately 500 grams but not less than 100 grams of the cleaned sample analyzed."[113]

The sample of grain for grading is cleaned to determine the dockage. Dockage is determined by first weighing the sample, then cleaning it using the screen sizes prescribed in the current *Grading Guide* to remove foreign material, then reweighing it. The difference in weights is expressed as a percentage and prescribes how much foreign material in the grain can be removed through mechanical separation (cleaning). Dockage includes weed seeds, stones, broken and damaged kernels, and seeds of other grain. The terminal then is responsible producing for the quantity of cleaned grain determined on the basis of the dockage. For example, a parcel of 80 tonnes with 10 percent dockage should yield 72 tonnes of cleaned grain.

The grain received into the terminals is graded on the basis of the primary standard samples for the grain.[114] The primary standard sample reflects the minimum quality of the grade.

High quality wheats are further segregated within grades on the basis of protein content. For protein content determination, a representative sample of wheat is ground into flour. A portion of the flour is placed in a vessel and the vessel is placed in a protein tester. The testing apparatus uses near-infrared reflectance to determine the protein content of the wheat. The wheat is then relegated into one of the protein classes within the grade.

Weighing of the grain is carried out by a terminal scale operator under the supervision of a weighman of the Weighing Division of the Canadian Grain Commission.

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[113] Canadian Grain Commission, *Official Grain Grading Guide* (1985 edition; Winnipeg: C.G.C., 1984), p.24.

[114] Grain which is shipped from the terminals must meet the current export standards.

Once the grain has been officially graded and weighed, the information is recorded and the Prairie shipper of the grain is issued a receipt containing all the pertinent information. The grade and weight of the grain are recorded as being received by the terminal and the terminal becomes responsible for that amount of grain at that grade.

Cleaning

Following the official inspection and weighing, the grain is released from the scale. Then the grain moves via gravity flow either to a cleaning bin or onto a conveyor to storage. The route which is taken is dependent on the type of grain. Grains such as wheat and barley are generally shipped to cleaning bins to await cleaning. Rye, flax and rapeseed are usually stored for cleaning at a later date as different equipment is used in cleaning these grains.

The terminals use high capacity cleaners--usually rotary indent cylinder type or screening machines. Indent cylinder machines use indentations the size of a kernel to separate by size. These machines are in banks and separate out the grain from the foreign material. Screening machines clean the grain by passing it over a series of slanted oscillating screens. The screens separate larger and smaller material from the grain by the size of the holes in the screens.

Some of the material which is separated from the grain by the cleaners is reclaimed. Heads of grain are reclaimed and threshed to remove the seeds. In the case of wheat, the kernels are returned to the appropriate storage bin. Oats are sized and are eventually used in export mixed feed oats. Smaller kernels are reclaimed by recleaning which separates the smaller seeds from the refuse in order that the kernels can be returned to the export grain. Other specialty cleaning machines for removing stones and other foreign material by specific gravity are also used to reclaim grain.

During the cleaning process, the integrity of the grain must be maintained in order to prevent different grades and/or protein segregations from being mixed. The grain must be cleaned in the terminal according to the standards set by the Canadian Grain Commission Inspection Office. Grain cleaned in the Inspection Office is cleaned on the basis of a relatively small sample whereas the elevator must clean large commercial quantities of grain. This creates problems for the terminal operator as some grain must be cleaned three times in order to bring the grain to the standards set by the Inspection Office.

Once the grain has been cleaned,it is elevated into a garner at the top of the workhouse . The grain is then released onto a high speed conveyor which moves the grain to the annex for storage.

Conditioning

Terminal elevators perform other processing functions in addition to cleaning the grain. These other functions-such as drying and fumigating--called conditioning, are not performed on all grain received at a terminal. They are only carried out as required. The frequency of these operations is usually dependent upon the harvest conditions on the Prairies during the past year. For example, grain harvested during good weather seldom has excess moisture and problems with insects.

Grain deemed tough by the Inspection Office may be blended with dry grain by the terminal. However, grain which has been determined to be damp or moist must be dried. Grain drying at the terminals, unlike cleaning, is not an integral part of normal operations. Therefore, damp and moist grain may be stored for several days before drying.

When drying several types of driers are used by terminals. The two most common types are the rack and column driers. While the configuration of these driers is different, the principle is the same. "Heat applied to grain during drying causes moisture inside the kernel to move to the surface where it is evaporated into the surrounding air, thus reducing moisture content in the kernel."[115]

The other conditioning operation performed at the terminals is fumigation. Fumigation, or treating of insect infested grain, is seldom required at the terminals due to the sub-zero temperature on the Prairies during the winter. However, if infested grain is discovered, it must be segregated from the rest of the grain and treated. In addition, the equipment and areas contacted by the infested grain may have to be treated to ensure the infestation does not spread to other grain.

Fumigation usually employs the use of pellets which give off a phostoxin gas. The pellets are fed into the grain as it is moved to the storage bin. The pellets exude the gas

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[115] Canadian International Grains Institute, *Grains and Oilseeds: Handling, Marketing, Processing* (3rd ed; Winnipeg: C.I.G.I., 1982), p.205.

which kills the insects in the sealed bin. Fumigation is carried out under the supervision of Agriculture Canada entomologists.

As well, purchasers may request that grain be treated prior to shipping. Malathion is usually used in this case and is sprayed on the grain as it moves in the shipping gallery.

Storage

The majority of the storage capacity available at terminal elevators is provided by annexes adjacent to the workhouse. Workhouse storage capacity is limited to grain awaiting processing. Following the completion of processing the grain is moved by a high speed conveyor to the annex.[116] See Figure IV-2 for a diagram of a terminal layout.

The delivery system for storing grain in the annexes is formed by a complex of conveyors and trippers. Major conveyors move the grain from the workhouse and automatically controlled or manually operated trippers divert the grain from the conveyor into the selected bin or on to another conveyor which moves it to the selected bin. Conveyors provide most of the horizontal movement of grain throughout the terminal and storage annexes. Conveyors are an integral part of the terminal, "A grain terminal contains about 9 miles of conveyor belt."[117]

The storage bins in terminal elevator annexes are generally constructed of cast-in-place concrete. Bins are either circular or star-shaped, with one star-shaped bin between several circular bins. The bins are constructed in this manner to utilize space efficiently and add strength to the building. The bins ususally have a hopper bottom to facilitate the discharge of grain from the bins.

The number of storage bins constructed at a terminal elevator is dependent upon the number of grains and grades which the terminal handles. The more grains and grades received at the terminal, the greater the number of storage bins required. For example, the new terminal elevator at Prince Rupert has fewer and larger bins than a comparable terminal in Vancouver as this facility was designed to handle only certain grades of Red Spring Wheat, barley and rapeseed. The size of the bins also differs between terminals. The star-shaped bins tend to be smaller than the circular bins as they are space-filling bins,

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[116] Terminals may have more than one annex. Annexes are constructed at terminals in response to demand for additional storage at the terminal. Therefore ages of the annexes at terminals vary.

[117] Alberta Wheat Pool, *Terminal Operations* (Calgary: A.W.P., n.d.), p.6.

but the size of the circular bins may vary due to differences in age of the bins and the requirements at the time of construction.

The length of time grain is stored at the terminal depends upon the particular grain and grade. Some grain is stored for up to two years due to circumstances beyond the control of the terminal operator.[118] grains may be stored for only a few days before being shipped. The average storage time for grain at Vancouver terminals is 30 days.[119]

Shipping

The shipping of export grain from the West Coast terminals is the major function of these facilities. The other functions performed by the terminals, while important, are ancillary to shipping. Shipping occurs when a vessel arrives at the terminal to load grain sold either by the C.W.B. or some other export shipper.

Prior to docking at a terminal elevator, the vessel is inspected by Agriculture Canada for sanitation, cleanliness and general condition to insure that the vessel condition will not affect the grain being loaded. Upon passing inspection, the vessel receives a certificate to allow loading. The vessel is advised by the British Columbia Grain Shippers Clearance Association at which terminal(s) to berth in order to receive the required grain.

The elevator company is informed of the quantities and grades of grain to be loaded on the vessel. The valves at the bottom of the appropriate bins are pulled either manually or electronically and the grain flows out of the bin on to one of the conveyors located in the basement of the annex. The grain is moved by the conveyor to the boot of one of the shipping legs . The grain is then elevated by the shipping leg and is discharged into a shipping garner (see Figure IV-3) in the same manner previously described for the receiving of grain. When released from the shipping garner, the grain flows into a shipping scale where it is officially weighed under the direction of a weighman of the Canadian Grain Commission and the weight is recorded.

Following the official weighing, the grain is released from the scale and is moved into shipping bins for temporary storage. The grain is discharged from the shipping bins

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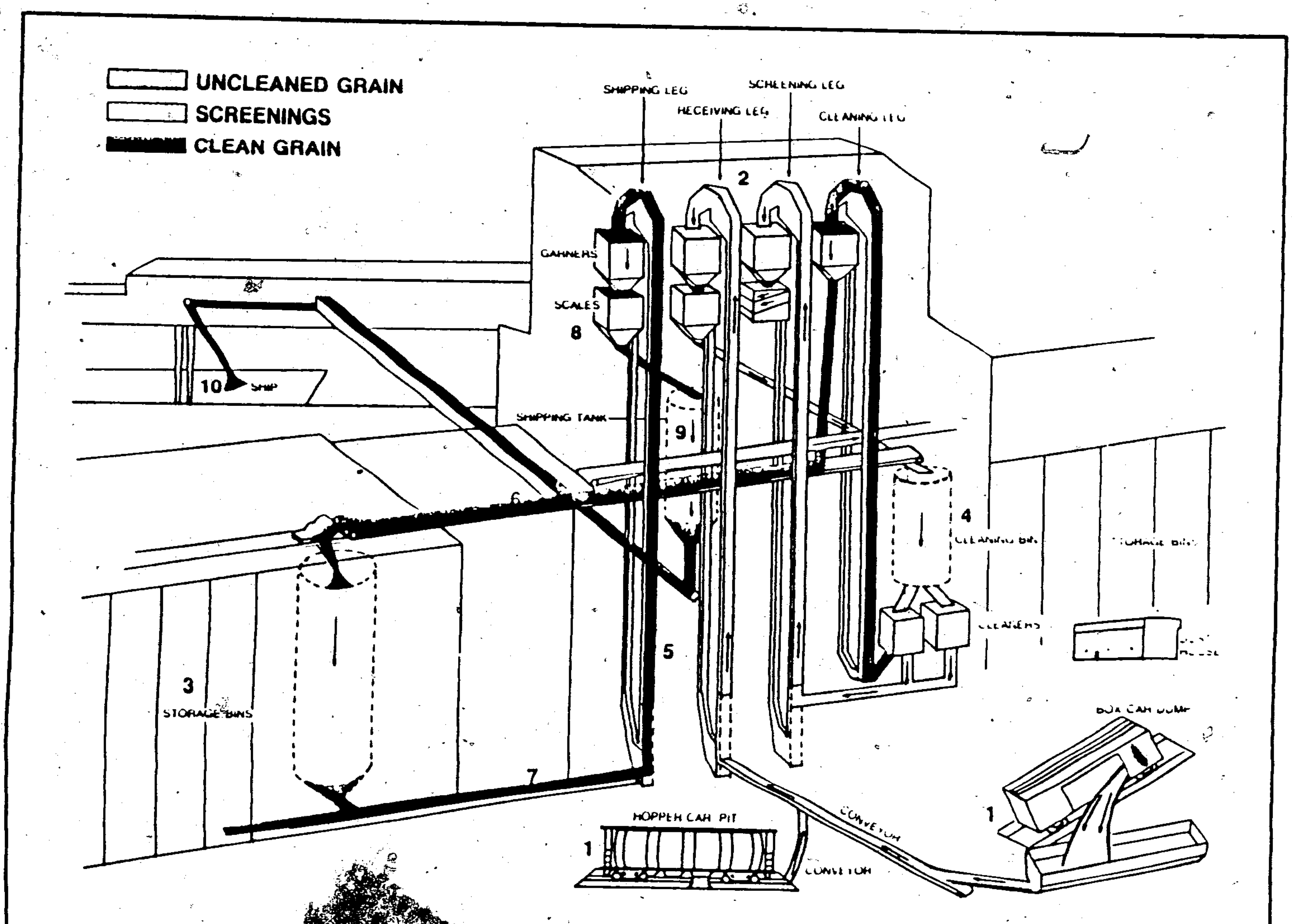
[118] Occurrence of two years, storage seldom happens at terminals. However, storage of this length can occur with farmer-owned grain, and condemned grain (grain unfit for shipping due to contamination by pesticide residues or poor quality).

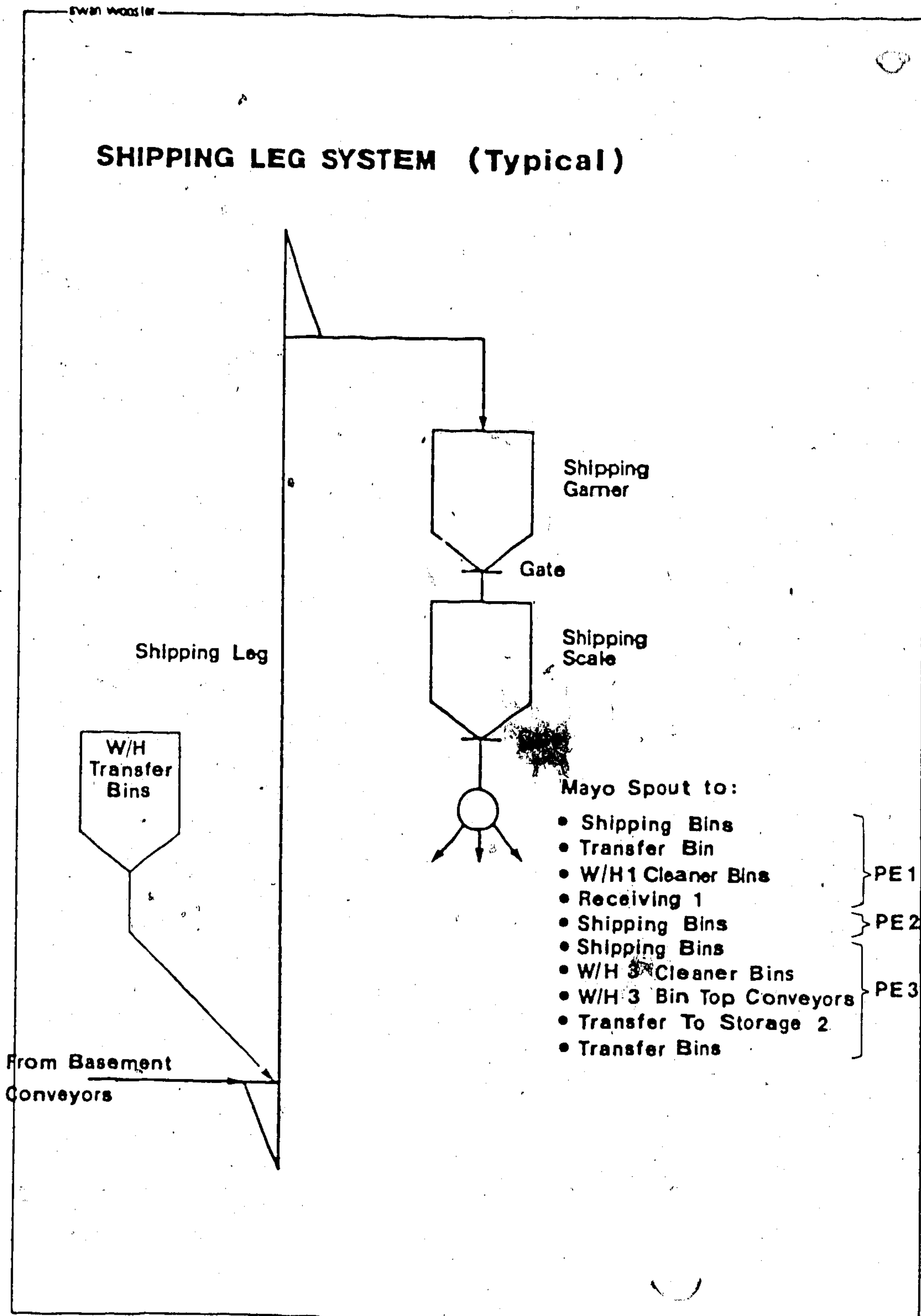
[119] Personal Communication , John T. Marchiori, A.W.P., Vancouver, February 1985.

Figure IV-2 Terminal Elevator Layout and Grain Flow



Source: Alberta Wheat [illegible] Terminal Operations,p.5.

Figure IV-3 Shipping Leg System.



Source: Swan - Wooster Engineering Co. Ltd., Alberta Wheat Pool Vancouver Terminal Simulation Analysis.

on to conveyor belts which transport the grain to the shipping gallery.

A shipping gallery is an elevated covered structure, containing conveyor belts and shipping spouts, which is located in the water (see Figure IV-4) The purpose of a gallery is to allow ships with large superstructures and deep drafts to be loaded with grain. Conveyors move grain from the workhouse through a suspended raised covered shed called a ramp. Once in the gallery trippers divert the grain on to other conveyors leading to shipping spouts. The grain is spouted from the gallery into the appropriate hold of the vessel. The loading rate of terminals is dependent upon the capacity of the conveyors leading to the gallery, the capacity of the spouts, and the number of spouts which can be used to load each hold of the vessel.

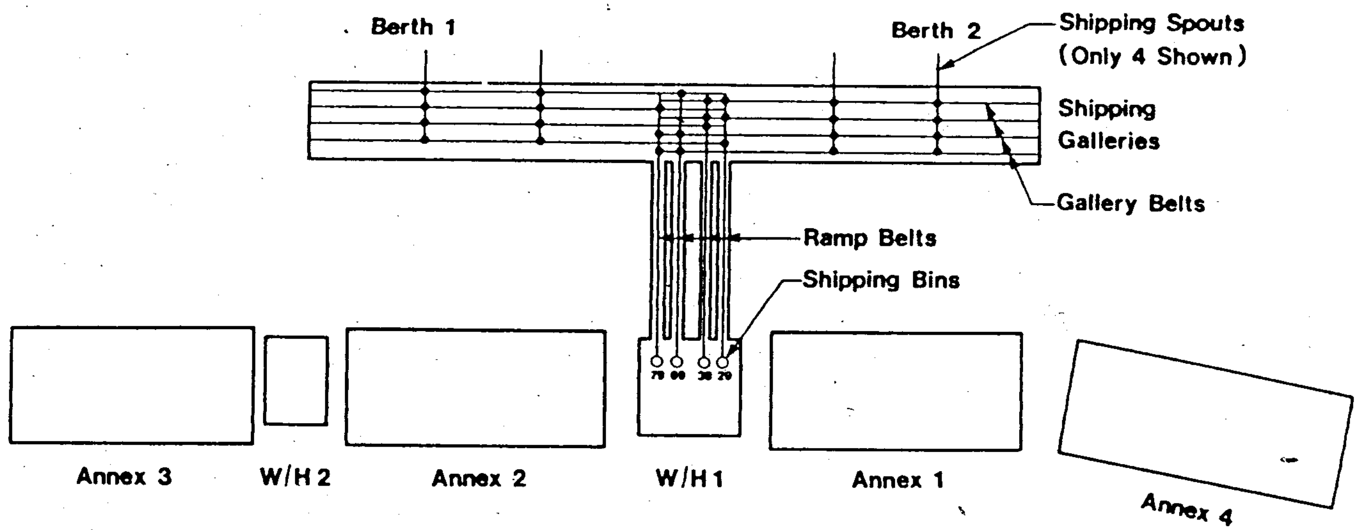
Between the weighing and the discharging of the grain into the ship's hold, an automatic sampler removes periodic samples of the grain being shipped. These samples are transported to the Insection Office of the Canadian Grain Commission for grading. Grain which is shipped must meet export standards which require the grain to be of average rather than minimum quality for the grade. Grain which does not meet standards must be unloaded from the ship at the terminal operator's expense. Following completion of loading, a "Certificate Final" is issued by the Canadian Grain Commission. The certificate certifies the weight and grades which have been loaded on to the ship. The Certificate Final is delivered to the shipper.

Blending

Blending is the mixing of parcels of grain and can only be carried out at the terminals with the permission of the Canadian Grain Commission. The *Canada Grain Act* prohibits the blending of No. 1 Hard Red Spring Wheat with No. 2 Hard Red Spring Wheat. However, separate parcels within each of these grades may be blended. Between grade blending is limited at the terminals to the lower quality Hard Red Spring Wheats and other grains.

Blending of grain is carried out at the terminals for several reasons. For one, tough grain is often blended with dry grain as this saves on drying costs and storage space. In addition, blending may be required to fulfill customer requirements.

Figure IV-4 Shiploading System Schematic.



Source: Swan - Wooster Engineering Co. Ltd., Alberta Wheat Pool Vancouver Terminal Simulation Analysis.

Screenings and Pellets

Byproducts of the cleaning operation and grain dust which is collected by the dust collection system in the terminals are processed mainly for export animal feed. The screenings--that is the seeds removed from the grain during the cleaning operation-are segregated and used in three products. The rethreshed oat heads and wild oats are separated into mixed feed oats. Other large seeds, broken and damaged kernels are designated as feed screening. Small seeds and grain dust are ground and mixed with the grain dust. Under pressure and using steam, the mixture is formed into cylindrical pellets. All three products, pellets are sold as feed in the off-shore feed market.

C. Organizations Affecting Terminal Operations

The Pacific Coast terminals are the final link in the handling and transportation system for Prairie grain exported through the West Coast. The terminals are subject to constraints imposed by federal and provincial legislation and the agencies which supervise the legislation. Other constraints are placed by Crown Corporations, semi-private and private companies and industry organizations. Following is a description of the major organizations, their roles in the grain industry and their affect on terminal elevator operations.

Canadian Grain Commission

Terminal elevators are declared by the *Canada Grain Act* as "works for the general advantage of Canada"[120] and are controlled by provisions under the *Act*. The Canadian Grain Commission is the federal government agency charged with administering the provisions of the *Act*. Therefore, the C.G.C. is the major organization affecting the operations of the terminal elevators.

The C.G.C. has a Chief Commissioner and two Commisioners who are appointed by the Governor in Council and report to the Minister of Agriculture. Located in the major grain-growing areas of Canada are five Assistant Commissioners who are appointed by the Governor in Council and report to the Commissioners. The operations of the C.G.C. are divided into five divisions. The five divisions are: Administration and Finance, Grain

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[120] Canada Grain Act *Statutes of Canada* c.7 s.43.

Inspection, Weighing, Economics and Statistics, and the Grain Research Laboratory. The Grain Inspection and Weighing Divisions have the most impact on terminal operations.

The Inspection Division is responsible for grading all the grain and grain by-products received and discharged at terminal elevators. The grading function is the primary responsibility of the Inspection Division but other functions are performed. Generally it is the grain inspectors at the terminals who discover insect infestations and notify the terminal operator. The Inspection Division also prepares the samples for the Eastern and Western Standards Committees to use in establishing primary and export standard samples. The Inspection Division has grain inspectors at the Pacific Coast terminals on a year-round basis. In order to perform the grading function grain inspectors must be at the terminal during the receiving and shipping of grain. The Inspection Division issues the Certificate Final following the loading of the grain on the vessel. Samples used for grading export shipments are retained for six months by the Division. These samples are used in the event that an importer questions the quality upon receipt.

The Weighing Division is responsible for the official weighing of all grain received and discharged by terminal elevators. Personnel from the Weighing Division supervise weighing and work in conjunction with the terminal's scaleman. The weights of grain received are recorded and the terminal is responsible for that amount of grain. Weighing Division personnel also record the amount of grain dischaged for use on the Certificate Final.

Other functions performed by Weighing Division personnel include conducting weighovers, essentially audits of the terminal's stocks. A weighover consists of comparing the amount of grain, including byproducts, in the elevator with the amounts received and discharged to determine if overages or shortages exist in each grade of grain. The maximum overage allowed is 0.25 of a percent for CWRS No. 1 and No. 2 wheat, and 0.50 percent for other grains except oilseeds, mixed grains and pellets. Maximum allowable overages for oilseeds, mixed grain and pellets are 2 percent.[121] Overages greater than these amounts are confiscated. Confiscated grain becomes the property of the C.W.B. when Board grains are involved and the property of the C.G.C. in the case of non-Board grains. Shortages must be replaced by the terminal at the terminal

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[121] Canada Grain Regulations. p.32.

operator's expense. However, in some cases overages may be applied to cover shortages by the C.G.C. The Weighing Division is also reponsible for periodic examination and testing of scales used at the terminals. The inspections are carried out to ensure the equipment has not been tampered with and is functioning correctly.

The Economics and Statistics Division is resonsible for licensing terminal elevators. Under this license, terminal elevators are:

1. Forbidden to accept infested or contaminated, or foreign, or any material that is not classified as grain or grain product, unless authorized by the Commission.
2. Elevator operators must accept all grain offered provided there is space available for that particular type and grade of grain.
3. Grain must be officially weighed and inspected by officers of the Commission when it arrives at a terminal elevator. The terminal operator must remove the dockage indicated on the inspection certificate. When grain is shipped from the terminal it must again be officially weighed and inspected.
4. The terminal operator must issue to the owner of the grain a terminal elevator receipt(formerly known as a warehouse receipt) when evidence has been obtained that all costs against the grain prior to its entering the terminal have been paid. This receipt must be registered with the Commission and submitted for cancellation when the grain is discharged.
5. When a terminal operator alters the grade of grain through drying or treatment, he must submit the terminal elevator receipt to the Commission for cancellation and issue a new terminal elevator receipt to the Commission for registration.
6. A terminal operator may not mix grain of any grade with grain of another grade unless authorized or ordered by the Commission.
7. The Commission may permit or order grades of grain to be mixed to facilitate grain sales, conserve storage space, or to enable grain to be dried or treated,
8. A terminal operator cannot discharge any grain containing dockage unless authorized by the Commission.
9. If grain is found to be infested or contaminated in any licensed terminal or transfer elevator, the operator must inform the Commission and treat or dispose of the grain as the Commission directs.[122]

The Economics and Statistics Division is also responsible for collecting information from the terminals regarding the costs of operations. This information is then used for setting the maximum tariffs an operator may charge for services at the terminal.

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[122] Canadian International Grain Institute, *Grains and Oilseed: Handling, Marketing,Processing* (3rd. ed. (Winnipeg: C.I.G.I., 1982), pp.80-81.

The Canadian Wheat Board

The Canadian Wheat Board is the sole seller of wheat, oats and barley for domestic human consumption and export from the designated area.[123] As wheat and barley are the two major grains exported by Canada, C.W.B. operations and policies affect the Pacific Coast terminal elevator operations.

The present Canadian Wheat Board was appointed in 1935 by the federal government as a voluntary marketing board for Western Canadian wheat. The Board set an initial payment (floor price) for wheat and farmers could sell wheat to the Board. The appointment of the C.W.B. was in response to erratic world wheat prices which affected Western Canadian wheat farmers and subsequently, the economy of the Prairies.

In 1943, the Board ceased to be voluntary and became the sole purchaser of Western Canadian wheat. In 1949, barley and oats came under the jurisdiction of the C.W.B. and, in 1967 the Canadian Wheat Board became a permanent Board.

The major responsiblities of the C.W.B. under the *Canadian Wheat Board Act* are to:

1. Market wheat, oats and barley delivered to it to the best advantage of producers.
2. Provide producers with initial payments established and guaranteed by the federal government.
3. Pool selling prices for the same grain so that producers get the same basic return for the same grain and grade delivered.
4. Equalize deliveries through quotas so that each producer gets his fair share of available markets.[124]

In order to fulfill these responsibilities, the C.W.B. utilizes the facilities of the grain companies. The companies are appointed as agents of the Board for handling Board grain and are paid for services rendered according to tariff rates set for the service.

The C.W.B. takes ownership of all Board grain which enters the terminal elevators. The Board then arranges grain shipments with either overseas customers or Canadian exporters. As the C.W.B. is the largest customer of terminal services, a delay in selling stocks in the terminal creates a reduction in the ability of the elevator

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[123] The designated area is essentiall all the grain production area in the three Prairie Provinces and the Peace River area of B.C.

[124] Charles F. Wilson, *Grain Marketing in Canada*, (Winnipeg: Canadian International Grains Institute, 1979), p.65. Wilson mentions one other responsibility; "Organize grain shipments to meet sales commitments in order to make the best use of handling and transportation facilities." This is now the responsibility of the Grain Transportaton Agency.

to turn over space. Conversely, if ships arrive before the required grain reaches the coast the terminals must work overtime to process the grain when it arrives.

The Grain Transportation Agency

The Grain Transportation Agency resulted from recommendations made in the Booz-Allen report in 1978. The Agency, a temporary organization for four years starting October 1979, became a permanent body in 1984. The responsibilities of the G.T.A. are:

1. to ensure that the available grain cars are allocated fairly between the Canadian Wheat Board and the non-Board sector, and
2. to develop and implement planning procedures which will ensure that the right grain is in the right place at the right time.[125]

The G.T.A., in addition to allocating rail cars to the C.W.B. and private companies, allocates rail cars to the terminals in Vancouver. When rail cars containing Board grains and rapeseed arrive at one of the assembly yards in Vancouver, the G.T.A. is notified by the railway. The cars are allocated to the individual terminals by the G.T.A. on the basis of available space and in which rail yard the cars are located. In the case of non-Board grains, the car is allocated to the original consignee.

The allocation of Board grains and rapeseed to terminals irrespective of the original consignee is called car-pooling. This process has increased the speed with which cars can be moved to terminals and be unloaded as pooling has reduced switching of cars between rail companies. Allocation on the basis of available space also provides an incentive for the terminals to turn over grain as quickly as possible in order to receive their share of the grain shipped through Vancouver.

In addition to the allocation of rail cars to Board grains and non-Board grains, producer cars are allocated through the C.G.C. Producer cars are allocated for non-Board[126] grains to producers who have enough quota acres and quota to fill a car. These producer cars are used either for the inland movement of grains or are sent to Vancouver with export grain. These carloads, unless containing contaminated grain, must be received by the terminals and the integrity of the parcel of grain, at

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[125] Grain Transportation Authority. *Moving Western Canadian Grain* (Winnipeg: G.T.A., n.d.), p.5..

[126] For the purposes of this thesis non-Board grain is grain which is not handled by the C.W.B. either domestically or in the export market. These grains included rapeseed, flax, rye and mustard sold in both the domestic and export market and feed wheat, oats and barley in the domestic feed market.

least on paper, must be maintained. Two types of problems evolve from producer car deliveries -- one is the maintenance of the paper by the terminal and the other is that there is no method of ensuring that the grain is of the correct grade until it is delivered. The G.T.A. allocates producer cars to the terminals on the same basis as other cars unless there is a specific terminal destination.

Agriculutre Canada

The direct effect of Agriculture Canada on the operations of the Pacific Coast terminal elevators is minimal. However, Agriculture Canada is responsible for the inspection of ships destined to load Canadian grain at the terminals. In addition, Agriculture Canada entomologists supervise fumigation at the terminals and inspect grain following fumigation to ensure the infestation has been controlled.

Agriculture Canada's major role in Canada's grain industry is to conduct research in areas such as plant breeding, pest research, fertilizer uses and agronomic practices. This research will ultimately affect the terminal elevators as it will determine the future course of grain production with respect to quantity and types of grain available for export.

The Railways

The railways provide the link between the primary elevators on the Prairies and the Pacific Coast terminal elevators. The bulk of the grain transported is supplied by Canadian National and Canadian Pacific Rail. C.N. is a Crown Corporation which operates a group of companies, one of which is a national rail system. C.P.R. is privately owned by Canadian Pacific Limited. C.N. rail lines service the northern areas of the Prairies and C.P.R. services the southern Prairies. These two railways move grain through the mountains to Vancouver and Prince Rupert.

Prince Rupert is served exclusively by C.N. whereas both C.N. and C.P.R. service Vancouver. In addition to the two national rail companies, three other rail companies operate in Vancouver--British Columbia Railways (B.C.R.), British Columbia Hydro and Power Authority Railway (B.C.H.)and Burlington Northern (B.N.). These three railways are not heavily involved in the movement of grain in Vancouver. However, the physical facilities owned by these companies are used by C.N. and C.P.R. to faciltiate the movment of grain in and around Vancouver.

The major functions performed by C.N. and C.P.R. with respect to terminal elevator operations are the delivery of full grain cars to the terminals and the removal of empty cars from the terminals. The performance of these functions affect the performance of terminals as cars not delivered in a timely manner result in a shutdown of receiving operations. Conversely, if empty cars are not picked up by the railways, the service trackage used for the runout of empty cars becomes plugged and the receiving operation at the terminals is shut down. Shutdowns of the receiving operation due to either of these two situations may adversely affect the throughput of the terminals. The average number of hours per week the terminals were delayed due to these conditions in 1981 and 1982 were: Pioneer Grain, 8.7 hours; S.W.P., 10.0 hours; A.W.P., 8.9 hours; P.E.L., 6.9 hours; and U.G.G., 3.9 hours.[127]

The railways' performance is affected by the physical limitations of the areas where they must operate. All grain moving to Vancouver is transported through three mountain passes in the Rocky Mountains and two passes in the Coastal Range. Mudslides, snowslides and train derailments in these passes can slow down the flow of grain to Vancouver. The availability of space for rail yards in and around Vancouver is limited, restricting construction of new yards or expansion of existing yards to increase the ability of the railways to sort and store cars. A third limitation is the space adjacent to the terminals for service trackage. As the Vancouver waterfront is crowded, space for expansion of service trackage to accomodate both full and empty cars is limited. The most acute shortage of service trackage exists at the A.W.P. terminal, where, in 1982 there was only enough service trackage to accomodate about 35 percent of the average daily throughput of the terminal.[128] A.W.P. is, therefore, very dependent on C.P.R. for expeditious movement of grain cars to ensure continous operation of the terminal.

Labour Unions

Operations at the Pacific Coast terminals are affected by many labour unions. Members of the Grain Handlers Union operate the receiving, cleaning, drying and other

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[127] Travacon Research Limited, *Vancouver Rail Access Study: Phase 1 Report* (Vancouver: Travacon Research Limited, 1983), p.46.
[128] *Ibid.*, p.47.

equipment in the terminals. The Inspectors and Weighmen of the C.G.C. are members of the Public Service Alliance of Canada. Ship loading operations are performed by members of the International Longshoreman's and Warehouseman's Union (I.L.W.U.). In addition, the railway employees, towboat workers and ship pilots are all members of unions.

The smooth operation of the terminals is dependent upon smooth labour-management relationships within all these areas, as a strike or lockouts can interrupt the flow of grain to export markets. Between 1972 and 1975, there were a total of 120 work days (16 percent of total work days) lost due to strikes and lockouts.[129] Disputes between labour and management which do not end in strikes or lockouts can also affect the productivity of the terminals through work slowdowns and poor attitudes among the workers. The multiplicity of unions involved in the process of exporting grain through the terminals affects throughput in many other ways. Differences in shift starting time, coffee breaks and meal times between the unions can effectively reduce the throughput. If meal and break times do not occur simultaneously, the flow stoppage is prolonged as certain operations require workers from two unions to work together.

British Columbia Grain Shippers Clearance Association

The British Columbia Grain Shippers Clearance Association acts as a clearing house for terminal elevator receipts for instore grain in the Vancouver terminal elevators. The Association is a non-profit organization directed by an eight member Board of Directors. The members of the association are export shippers who belong to the Vancouver Grain Exchange and are acceptable to the Board of Directors. Operations of the Association are paid through membership fees and levies assessed to the exporters and the ships.

The main function of the Association is to expedite grain shipments from the Vancouver terminals. To accomplish this, the Association advises vessels of the terminals to berth for loading. The Association transfers terminal elevator receipts to minimize the number of moves vessels are required to make in order to load. For example, a shipper may have grain destined for loading on a vessel instore at three terminals. Instead of the vessel berthing at these three terminals, a transfer of terminal elevator receipts allows the vessel to load completely at one terminal and ownership of the shipper's grain at the other

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[129] Western Transportation Advisory Council, *Port of Vancouver Terminal Grain Handling* (Reprint #3, Vancouver: WESTAC. 1979), p.8.

two terminals is transferred to the owners of the grain used to complete the load at the loading terminal. This action facilitates export movement as paper is easier to transfer than ships.

There are two types of export shippers that belong to the Association--terminal elevator owners or operators and companies which have no terminal facilities on the Pacific Coast. The non-terminal owned or operator export shippers utilize the terminal facilities on the Pacific Coast on a user pay basis. Tariffs for elevator services are paid by the shipper to the terminals according to rates which have been set by the terminal operator. Although there are five owned or operated terminal companies in Vancouver, there are 13 accredited C.W.B. exporters [130] Board, *Canadian Grain Handbook 1983-84 Crop Year*, Board, *Canadian Grain Handbook 1983-84 Crop Year*, who utilize the facilities. The shippers who do not own facilities also affect terminal operations by using the terminal facilities.

Organizations which affect the operation of terminal elevators are not limited to those described above. Many organizations have an indirect effect on terminal elevators by impacting on other sectors of the Western Canadian grain industry. General Farm Organizations such as the National Farmers Union, the Canadian Federation of Agriculture and Unifarm influence governments' policy making processes related to agriculture, which may affect terminal elevators. Farmer owned cooperative grain companies can affect terminal operations through decisions made by their delegates. Commodity groups influence the production of grain and support research which may increase production. In addition, domestic users of grain affect terminals through the quantity available for export. However, the organizations described in this section have the greatest effect on terminal elevator operations, through policy, operation and responsibility.

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[130] Canadian Wheat Board, *Canadian Grain Handbook 1983-84 Crop Year* (Winnipeg: C.W.B., 1983), p.5.

V. Grain Handling and Transportation Systems in Canada, United States and Australia

Major differences exist in the grain handling and transportation systems of the major grain exporting countries. These differences affect the operations of each country's export terminal elevators. Some Canadian grain producers are concerned that the operations of terminal elevators in competing nations are more efficient than those in Canada.

A comparison of terminal operations without analyzing the systems which deliver grain to the terminals would overlook many of the factors which place constraints on the the terminals. Following is a discussion describing the grain handling and transportation systems in Canada, the U.S. and Australia and the differences which affect terminal operations.

A. Location of Export Ports

The location of the grain growing areas in the three countries affected the development of their respective grain transportation systems. The grain-producing area of Western Canada is isolated from export ports by physical barriers--the mountain ranges to the west and the Laurentian shield to the east. In addition, the distance of the grain producing area to the ports is another factor. The average loaded miles which grain trains must travel from the Prairies to ports is 911 miles (1458 kilometers).[131]

The grain-producing areas in Australia tend to be adjacent to coastal areas which means there are relatively short distances between producing areas and export ports. The average hauling distance from wheat-producing areas to export terminals is 360 kilometers (225 miles).[132] Except for the Great Dividing Range, which stands between the producing areas and the coast in Queensland and New South Wales, there are few physical barriers which affect the transportation of grain in Australia.

Grain production in the U.S. takes place in areas closer to export ports than in Canada. Few physical barriers, except the western mountain ranges which extend south

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[131] Snavely, King and Associates. *1980 Costs and Revenues Incurred by the Railways in the Transportation of Grain under the Statutory Rates* (Washington: Snavely, King and Associates, 1982), p.43, table 16. (Prepared for the Grain Transportaion Directorate, Transport Canada.).

[132] Robert L. Sargent, *Australian and United States Wheat Marketing Systems: A Comparison* , Extension Bulletin No.596. (Moscow: University of Idaho, 1980), p.23, table 25.

from Canada, impair the transportation network. In addition, major inland waterways augument methods of grain transportation. Resulting in easier access from the grain-producing areass to the ports.

Climatic factors also affect the grain transportation systems. Due to freeze-up the number of ports available for exporting grain from Canada is less than in either Australia or the U.S.

Canada has two major grain export ports--Vancouver, British Columbia and Thunder Bay, Ontario. Only Vancouver is open to ocean shipping on year-round. Thunder Bay, located on Lake Superior, is open 8.5 months of the year and grain shipped through Thunder Bay must travel through the Great Lakes, the Welland Canal and the St. Lawrence Seaway, a distance of about 3,000 kilometers,[133] to reach the ocean. Export terminals are also located at Prince Rupert, British Columbia and Churchill, Manitoba. Both of these ports handle less than 10 percent of Canada's grain exports. In addition, Churchill has a relatively short shipping season of three months a year.

The U.S. has access to ocean shipping through the Eastern Seaboard, the Gulf of Mexico, the Pacific Coast and the Great Lakes-St.Lawrence route. Only the Great Lakes-St.Lawrence route and the northern section of the Mississippi system are closed down in winter, the other three shipping areas are open on a year-round basis. During the period 1974-1976 only 9.2 percent of U.S. export grain[134] was shipped through the Great Lakes-St. Lawrence Seaway system, whereas 54 percent of Canadian exports between 1973/74-1982/83 were shipped through this route.[135]

Australia has 19 ports[136] with export terminal elevators. These ports are along the east, south and southwest coast of the country and are open year-round.

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[133] C.I.G.I., *Grains and Oilseed: Handling, Marketing, Processing* (3rd. ed; Winnipeg: C.I.G.I., 1982), P.167.

[134] Arther B. Sogn, "The United States Grain Industry" paper presented to Eleventh International Grain Industry Course, Winnipeg, May 31, 1979. (Mimeograph).

[135] Canada Grains Council, *Statistical Handbook '84* (Winnipeg: C.G.C., 1984), p.72 table 25.

[136] Bureau of Agricultural Economics, *Wheat Marketing in Australia: An Economic Evaluation.* Occasional Paper No. 86 (Canberra: Australian Government Publishing Service, 1983), p.56.

B. Transportation Systems

Development of the three countries' transportation networks were determined by political and geographic factors. As as result, the systems in the three countries are not alike.

Canada

The transportation of grain to export terminals in Canada relies heavily upon the railway system. Branch lines are used to gain access to country elevators in the producing areas. Grain cars are loaded at the primary (country) elevators on the branch lines and the cars are moved along the branch lines to a central location where trains of grain cars are assembled for movement along the main lines to the terminals.

Due to the geography of the country and the location of the export ports, the main lines of the railways run east and west. Grain is, therefore, moved either west to the Pacific Coast or east to Thunder Bay. A limited amount of grain from northern areas of Manitoba and Saskatchewan is moved northwards by rail to Churchill for export.

Each rail car loaded at the primary elevators contains one grade of grain. However, an elevator may load several cars, each with a different grade or grain. When these cars are moved to a central location, all the cars for a certain destination are assembled into a train. The grain train, therefore, usually has several types of grain with several different grades. This assemblage causes problems at the terminals as the sequence of car lots received contain different grades and grains.

The two transcontinenal railways, C.P.R. and C.N.R., which transport grain to the ports tend to collect grain from different parts of the Prairies. C.N.R. serves the northern Prairies and C.P.R. serves the southern Prairies. The grain is delivered to either Vancouver or Thunder Bay and may be received by any of the terminals. The result is that regional differences in quality and types of grain produced due to climatic differences between areas of production may be lost at the ports. This is compounded by a minimal amount of elevator specialization with respect to the types of grain handled by a terminal.[137] Grain

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[137] Conversely, with Board grains a co-mingling of grain of a particular grade is required. Export standards are the average of grading factors in a grade which necessitates a range of quality being received. Car pooling has led to some terminals receiving grain from either C.N. or C.P., and this has resulted in difficulties in receiving average overall quality.

characteristics caused by to climatic differences between the northern and southern Prairies is lost as all grains for export come together at a few ports with no terminal elevator specialization.

United States

The U.S. grain transportation system uses three modes of transportation -- rail, trucks and inland water routes. Producers in the U.S., like those in Canada, deliver grain to country elevators. The grain is moved from the country elevators either by truck or rail to terminals or sub-terminals.[138] Grain assembled at the sub-terminals is either sold directly into the domestic market or is sold to terminal elevators at major centres or at export ports.

Grain is moved from these sub-terminals either by unit trains, trucks or, in some cases, by barge. Export grain sold from terminals located in major centres is shipped via rail or barge to the port terminals for ocean shipment. Grading and weighing of the grain is usually done at the sub-terminals or at the terminals by Inspectors of the Federal Grain Inspection Service (F.G.I.S.) or their agents and is thereby not required at the export terminals.

The U.S. has several regional and transcontinental railways which are used for the transportation of grain. In addition, there are several navigable inland water routes in close proximity to grain-producing areas which are used extensively for shipping grain from the inland terminals to export terminals. The diversity of the transportation system in conjunction with the number of export ports, helps to segregate the export grain so that the export terminals are able to specialize in shipping certain grains.

Australia

In part due to the proximity of the grain-producing areas to the numerous export ports and distances between these ports, Australia is better able to keep grain grown in one area separate from grain grown in other areas. The rail system in Australia was developed within each state and was designed for intra-state transportation. The state rail

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[138] Sub-terminals are large high-throughput elevators located away from major centres and close to grain producing areas which are used as assembly points for large quantities of grain.

systems were developed to move commodities produced inland to the various ports within the state. As rail transportaion was built on an individual state basis, different rail gauges were used in several states which prevented easy development of inter-state transportation.

The Australian grain producer, unlike his counterpart in Canada and the U.S., delivers the majority of his grain to a Bulk Handling Authority (B.H.A.)[139] at harvest. Grain is usually delivered to one of the country facilities by producers where it is stored until it is required for either domestic consumption or export.

In some states the grain-producing area is close enough to the coast that producers deliver their grain directly to the port terminals. Grain from inland B.H.A. facilities is moved by rail on unit trains to the export terminals. However, the majority of the grain moves within state directly from country facilities to port.

Some grain is moved via the Australian National Railways to port terminals in another state. This occurs most frequently with grain produced in New South Wales and shipped through ports in the State of Victoria.[140] Inter-state grain transportation is carried out to reduce the distance the grain must travel to port and avoid rough terrain which may limit the size of trains. In the States of New South Wales and Queensland, the Great Dividing Range limits the number of cars per train to between 25 and 50 cars.[141] However, due to the close proximity of the grain-producing areas to export ports and the intra-state rail networks, Australian grains can be more easily segregated at different export ports and terminals than can Canadian grains.

C. Climatic Factors Affecting Production, Handling and Storage

The climatic factors which affect production in the three countries also affect the handling and storage of grain. These climatic factors are not necessarily detrimental to any of the countries and some provide distinct advantages for each of the countries.

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[139] The B.H.A.'s are either state-run or producer cooperatives with statutory authority. In the case of wheat, the B.H.A.'s act as agents for the Australian Wheat Board. The B.H.A.'s own and operate the grain handling facilities including silos, country elevators, sub-terminals port terminals and temporary storage facilities.

[140] Robert L. Sargent, *Australian and United States Wheat Marketing Systems: A Comparison* Extension Bulletin No. 596. (Moscow: University of Idaho, 1980), p. 23.

[141] *Ibid*.

The short, hot and relatively dry growing season in Western Canada which allows the production of premium, high protein hard red spring wheats also necessitates rapid harvesting of the grain prior to the onset of winter. The short harvesting season often requires cutting the grain prior to harvesting to speed up the ripening and drying process. This results in weed seeds becoming mixed with the grain during harvesting operations and necessitates the grain being cleaned prior to export.

In Australia and many parts of the U.S., grain can ripen while standing and therefore is often harvested without prior cutting. This prevents weed seeds from becoming mixed with the grain and results in a cleaner crop. In addition, the longer the grain is left to stand the greater probability of the weeds dying back and releasing their seeds onto the ground. This assists in preventing the weed seeds from being mixed with harvested grain.

Cleaner grain may preclude the requirement of cleaning the grain prior to export, but it may also result in greater weed control problems due to the increase in weed seed dissemination. However, from a terminal operations point of view, receiving clean grain results in fewer operations at the terminal.

Climatic factors also have an important role in the storage of grain. In Western Canada, the sub-zero winter temperatures assist in the prevention of insects infesting stored grain. Grain which is reasonably dry when placed into on-farm storage is unlikely to become infested with insect pests.

The same does not apply in much of the U.S. grain belt and Australia where temperatures are higher in winter. Infestation of insects is a persistent problem associated with grain storage in these areas and requires constant attention and treatment. In addition, Australia's warm moist climate makes fungal molds a stored grain problem not expereinced in Canada.

Climate also affects the production of grain crops in the three counties. Adverse weather during the growing season and/or the harvesting period may reduce the quantity and quality of the grain available for export sales. The reduction in production due to adverse weather conditions is apparently greater in Australia than in the other two countries.

Production varies considerably because of inconsistent rainfall throughout the vast-grain producing areas. An Australian official stated that Australia's wheat production was 60 percent more variable than that of the United States and

Canada.[142]

Production variability places burdens on the handling and storage facilities in Australia more so than in the other two countries because of the emphasis on off-farm storage. In years of poor crops, too little grain is moved through the system to justify the expenditure on facilities, while in years of exceptional crops, there is more grain than storage, thus taxing the ability of the system to efficiently handle the crop.

D. Marketing Methods

The methods which producers in the three countries use to market their grain have an impact on the operations of their terminal elevators. Canada and Australia have statutory marketing agencies responsible for selling the majority of grain produced. However, differences exist in the types and numbers of these statutory agencies. Producers in the U.S., on the other hand, market their grain through open market methods without the aid of statutory agencies. Following is a discussion of grain marketing methods in the three countries.

Canada

The Canadian Wheat Board is the sole purchaser of Western Canadian wheat, barley and oats destined for export or domestic human consumption. The C.W.B. sells the grain to domestic processors, exporters or foreign buyers.

Producers in Western Canada are provided with an equal opportunity to sell their Board grains through the use of a quota system. The concept of equal returns among producers, irrespective of delivery time throughout the crop year, is maintained by the use of pools for the three grains controlled by the C.W.B.[143]

The producer receives an initial payment for his grain at the time of delivery to a C.W.B. agent. An adjustment payment may be made during the crop year and a final payment is made after the conclusion of the crop year. The final payment is based on the average price received by the C.W.B. for the grain sold.

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[142] Comptroller General of the United States (1976) *Grain Marketing Systems in Argentina, Australia, Canada and the European Community: Soybean Marketing System in Brazil.* (Washington: U.S. General Accounting Office, May 1976), p.18.

[143] Six pools exist for wheat, durum, regular barley, designated barley, oats and designated oats.

All producers receive the same initial and final payments (except for deductions for transportation charge differences) for the same grade of grain regardless of when the delivery was made to the C.W.B. during the crop year. The use of delivery quotas and price-pooling facilitates the orderly marketing of these grains in Western Canada and assists in preventing too much grain being delivered at one time, overburdening the handling and transportation system. However, the system places the onus of storage upon the producer, who receives no remuneration for performing this function throughout the crop year due to the use of price pooling.

Grains in Western Canada, other than those controlled by the C.W.B., are sold by producers through an open market system. Several options are open to producers for marketing their non-Board grains. These options include direct selling to grain companies or feedmills, contracts with processors or grain companies, use of the commodity exchange and direct sale to an exporter through the use of producer cars.

Although the open market provides producers with a number of marketing options, grains destined for export, and to some extent, domestic sales are limited by the capacity of the handling and transportation system. The orderly flow of these grains is maintained by the use of delivery quotas to ensure that the system is not overburdened with grain delivered at the same time. Some open market options circumvent quotas and allow producers to sell their product at any time, for example interfarm and feedlot sales, albeit they may receive a lower price for their product than from some other option.

Other open market options available to producers can use storage space in the handling system. Producers deliver grain to an elevator and store it until an acceptable price is reached. In addition, producer cars can be used to deliver grain to a terminal elevator. The grain is held in-store until an acceptable price is offered. In both cases, the producer is required to pay storage charges which may cost more than he realizes from the increased price. Storage of grain in primary and terminal elevators by both producers and grain merchants reduces the amount of space which can be turned over rapidly and thus reduces throughput.

Conversely, the options available for marketing non-Board grains may compensate the producer for storing grain on-farm and facilitate the smooth flow of grain through the system. This is accomplished when the price for a product increases and transportation is available. An increase in price usually indicates an increased demand for the product--an indicator that a ready market is available. Transportation is usually made available for products in high demand as these products will be turned over quickly and do not tie up facilities in the system, thus increasing the efficiency of the system.

Australia

The marketing of all major export grains in Australia is accomplished through the use of marketing boards. These marketing boards are either state-run statutory boards or producer cooperatives with statutory authority which operate as pools. The Australian Wheat Board is the sole purchaser of wheat.

> By statutory authority reinforced by the 1978 High Court decision, all wheat moving off-farm - except wheat transferred from the farm where it was grown to another farm under the same ownership - must be delivered to AWB licensed receivers. Under the current Stabilization Act, wheat may also be delivered to nonlicensed receivers but only with prior AWB approval.[144]

The B.H.A.'s in each state, either a statutory state agency or a producer cooperative, act as licensed receivers for the A.W.B. As well, some grain processors and exporters are licensed as A.W.B. receivers.

The A.W.B. is required to accept all wheat delivered to the Board. However, during times when storage facilities are full, producers are requested to store wheat on-farm and are compensated for this storage. In 1979, this compensation amounted to about $A2.00 per ton.[145] The delivery of all wheat to the A.W.B. ensures that Australia is able to control the flow of wheat through the system in an orderly manner to meet export demands.

Marketing of grains other than wheat in Australia occurs through statutory marketing boards or producer cooperative pools, some of which have statutory standing. Unless sold between farms, these grains must be sold through the boards and the returns are pooled to all producers. These boards act much the same as the C.W.B. in maintaining the orderly marketing of these grains. By requiring all major grains to be delivered to licensed receivers, the boards know how much of each grain and grade is available for export. Grains not falling under a statutory marketing authority are generally limited in

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[144] U.S.D.A. *Australia: Production and Marketing of Grain for Export; A Competition Report* FAS M-298 (Washington: U.S.D.A.,Foreign Agriculture Service, October 1980), p.16.
[145] *Ibid.*, p.20.

importance with respect to the export market and thus have minimum affect on grain flows through the system.

The Australian system of pooling also ensures that producers are treated equally. However, producers may wait up to five years before they receive their final payment for the grain.

United States

The U.S. grain marketing system is an open market system with several options open to producers, much the same as the open market system for non-Board grains in Canada. Government involvement in the U.S. grain industry is restricted to support payments, floor pricing and loan arrangements, rather than direct involvement through marketing boards.

U.S. producers sell their grain directly to local elevators, sub-terminals, inland terminals, or in some cases directly to processors. Grain delivered to the elevators and terminals can either be sold at the time of delivery or held in-store until such time that the price rises to the producers' expectations.

Other options open to producers are foward contracting with a grain company or processor and the use of the commodity exchanges. As there are no statutory marketing boards or price pooling arrangements, producers are open to price risk and it is up to them to chose the best method of reducing price risk within the marketing options. Price risk is reduced by some producers through hedging their grain on one of the commodity exchanges.

In addition, the U.S. government has a variety of programs which provide floor and target prices or it can purchase grain indirectly through loan arrangements. The loan program[146] involves the producer using his grain as collateral on a loan received from the government. If the price does not reach the price for which the loan was made the producer turns over the grain to the government. However, much of the government-acquired grain is used as foreign aid or is held in reserve.

Grain which is sold into the market place and not to the government is sold to either private or cooperative grain companies for further sale to other purchasers. The

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[146] The Commodity Credit Corporation is the Government agency which operates the loan program.

price paid to the producer reflects the demand for the particular grain which assists in regulating the flow of grain into the system. Depending upon the year, producers may be compensated for storing grain on-farm. This occurs if the price of the grain increases late in the crop year.

E. Handling and Storage Systems

The grain handling and storage systems used in the three countries developed to fulfill the particular requirements of their respective grain industries. The export terminals in these countries tend to be similar in operation with repect to the storage and shipping of grain. However, differences in grain processing operations at the terminals occur due to the nature of the handling and storage facilities which foward grain to the export terminals. Handling and storage facility access and procedure differences are briefly described in the following section.

Canada

The backbone of the Western Canadian grain handling system is the primary (country) elevator. The majority (71.3 percent between 1976/77 and 1980/81)[147] of Western Canadian grain is delivered by producers to primary elevators. Grain is stored at the primary elevators until enough grain, in a specific grade, is collected to load a grain car.[148]

The time when producers may deliver grain to the elevator is determined by the quota system. Delivery quotas for individual producers are based upon acres allocated to a crop and the number of bushels per acre allowed by the Canadian Wheat Board at that time. The opening of a quota for a grade of grain is dependent upon the projected or actual sale of that grade of grain in the near future. The quota system, therefore, dictates when the producer may delive his grain to a primary elevator and how much of that grain he may deliver.

The quota system necessitates storage of Western Canadian export grain three levels -on-farm, primary elevators and terminal elevators. In additon, there is storage of

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[147] Canada Grains Council, *Prospects for the Prairie Grain Industry 1990* (Winnipeg: C.G.C., 1980), p.120, fig.4.

[148] The amount of grain required to fill a car is approximately 40-50 tonnes for a box car and 80-100 tonnes for a hopper car.

export grain at transfer elevators and inland terminals. Transfer elevators store grain which has already passed through terminals, and as such, act in a different capacity than do the other storage facilities. The inland terminals, of which there are now only two, are of limited importance as storage facilities for export grain due to their limited number.

Grain received from the producer at the primary elevator is graded by the elevator manager and dockage is assessed. The assigned grade is the basis of payment to the producer. However, this grade is not an official grade as official grades can only be determined by Inspectors of the Canadian Grain Commission, so the grain must be graded at the terminals for export.

At the primary elevator grain is binned with other parcels of grain with the same grade. Although some of the newer primary elevators have drying and cleaning facilities most of the grain shipped from primary elevators to the terminals is in the same condition as it was received. It is due to this factor that grain must be cleaned and dried, if necessary, upon arrival at the terminals before it can be shipped for export.

United States

The handling and storage of grain in the U.S. is quite similar to the Canadian situation. However, there are some notable differences between the two countries. Grain producers in the U.S. are not limited by quotas in their sales of export grain. Producers may sell their grain whenever they wish as long they are willing to accept the price. Therefore, the orderly flow of grain through the system is regulated by market price rather than by government intervention as in Canada. The decision whether or not to store grain on the farm is made by the producer on the basis of his profit requirement and not by government agencies.

Grain companies in the U.S. make more use of inland terminal and sub-terminal facilities than do the companies which operate in Canada. Sub-terminals act as collection points for grain from given areas. Grain is received at the sub-terminals from either country elevators or directly from the producers. As previously mentioned, grain is sold from the sub-terminals to the domestic market or the export market through other terminals.

Inspection of the grain is carried out by agents of the F.G.I.S. and is forwarded from the sub-terminal under that grade. Grain destined for export terminals is accepted at the specified grade which precludes grading at those terminals. In addition, railcar loads of grain shipped from sub-terminals are weighed prior to being shipped to the port terminals and reweighing is not required upon arrival as in the Canadian system. The use of these origin (O.G.) grades and weights is a major difference between the U.S. and Canada, and accounts for some of the differences in unloading time between export terminals in the two countries.

Inland terminals, often located along inland water routes, are also employed as collection centres in the U.S. These terminals receive grain from sub-terminals, country elevators and directly from producers. Grain received at these terminals may be cleaned, dried and otherwise conditioned prior to being sold. Export grain is usually shipped from these terminals by barge or unit trains. Grain which has not been previously graded is graded at these terminals by agents of the F.G.I.S.

Export terminals in the U.S. differ in operations from their Canadian counterparts as a limited amount of processing takes place at these terminals. In Canada, the majority of the grain received at the export terminals must be weighed, graded and cleaned.

Australia

The Australian grain handling and storage system contains very minimal on-farm storage. Producers deliver grain to the B.H.A.'s in their respective states as soon as possible after harvest. The B.H.A.'s operate the storage and handling systems to which producers deliver their grain. Samples of most grains must be delivered to a B.H.A. for grading prior to delivery of the grain. Since most handling facilities in Australia do not have cleaning and drying equipment, grain must be in relatively good condition at the time of delivery.

The Australian system uses port terminals, sub-terminals, storage silos, country elevators and temporary storage facilities to accomodate the grain received. Temporary storage facilities consist of either 1)piling the grain on plastic or asphalt pads which are cribbed on the sides and covered by plastic or 2)pits dug in well drained areas which are covered by plastic and then earth.[149] Permanent flat warehouses are also used for the storage of grain to augment the silos and country elevators.

Grain is sorted on the basis of grade and protein levels and is segregated in storage. To assist in segregating the different grades:

> The B.H.A.s restrict the number of varieties and types that will be accepted at various elevator locations as a means of avoiding segregations problems.[150]

Handling problems occur with these types of storage facilities. Grain stored in the flat warehouses must be augered through the adjacent silos or elevators for loading into rail cars. This activity causes an increase in the labour required for loading grain. The temporary storage facilities also create loading problems as the grain must be removed using front-end loaders or portable augers. The grain then is loaded onto the rail cars through the silos or elevators.

The Australian system for handling and storing grain has the advantage of minimizing the required amount of on-farm storage. However, through the lack of on-farm storage additional burdens are placed upon the B.H.A.s to provide storage during bumper crop years. The effect of this is pointed out by Sargent:

> The expansion of the wheat growing area and of production, combined with world-wide inflation has placed other strains on the B.H.A. systems. New, permanent facilities have become necessary and, of course, are increasingly expensive. This tends to be reflected in the storage and handling charges. These charges doubled from 1939 to 1955, doubled again by 1972 and again by 1977. They actually declined from 3.6 cents per bushel ($A 1.33 per tonne) in 1939 to 2.7 cents ($A.99 per tonne) in 1945, but in 1977 stood at 30.9 cents per bushel ($A 11.36 per tonne) an 11-fold increase.[151]

F. Handling and Transportation Charges

Charges paid by producers, grain merchants and other users of the grain handling and transportation system are determined by different mechanisms in the three countries. The method of determining these charges (tariffs) reflects the structure of the marketing system in each country.

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[149] Robert L. Sargent, *Australia and United States Wheat Marketing Systems: A Comparison* Extension Bulletin No. 596 (Moscow: University of Idaho, 1980), p. 15.
[150] *Ibid.*
[151] *Ibid.*, p. 16.

Canada

The Canadian Grain Commission sets the maximum tariffs which grain companies in Canada may charge users for the services provided by the elevators. These services include storage, elevation, and other operations. The maximum tariffs are in effect throughout Canada with respect to grain produced on the Prairies. As long as their rates are below the maximum, the grain companies are at liberty to set their rates competitively in order to attract business. The Canadian Grain Commission receives submissions from the grain companies each year concerning the costs of operating their elevators. The Commission uses these submissions to establish tariffs for the coming crop year.

Rail rates for transporting export grain are regulated by the federal government. Prior to passage of the *Western Grain Transportation Act* in 1983, statutory freight rates (known as the "Crow Rate") set during the 1920's were charged for the transport of grains destined for export. Rail car allocation is also regulated in Canada by a federal government agency, the Grain Transportation Agency, which allocates cars on the basis of sales, handlings and quotas to ensure an equitable distribution to all users of rail cars.

Australia

Australia is similar to Canada in that handling charges and transportation rates are regulated. The B.H.A.'s set the charges for grain handling in each state and this charge is paid by the producer. Rail charges are set by the state-run railways based upon the distance from delivery point to the nearest export terminal.

United States

Companies in the U.S. are under no regulations with respect to handling and storage charges. Companies may, therefore, adjust their charges according to the costs of operation and the local supply and demand situation. Since the deregulation of the railways, the railways compete with each other, trucking firms and river transport for a share of the grain transportation market. This competition has decreased the cost of transporting grain to the export terminals in the U.S. Rail companies also offer discounts to shippers for multiple and unit trains of grain from the same location. This has increased the use of unit trains by the grain companies and has assisted in increasing throughput at the terminals.

G. Summary

Discussion in this Chapter was limited to the dominant factors of geography, climate and marketing systems which affected the development of grain handling and transportation systems within Canada, Australia, and the U.S. Many of the political factors which influenced the development of the grain handling and transportation systems have not been dealt witn in this Chapter. However, political factors have directly affected the marketing systems (i.e. quotas, pooling, statutory authorities), which in turn, have influenced the development of the grain handling and transportation system.

VI. Data Requirements, Problems and Analyses

A system is "the connection or manner of connection of parts as related to a whole or the parts collectively so related."[152]

Grain grading in Canada is a system which encompasses the physical operation of assigning grades to grains and the rules and regulations which dictate where, when and how these grades are assigned. The multifaceted operations of a terminal elevator form another system, a system in which the flow of grain and the operations performed change according to the product handled.

The effect of the Canadian grain grading system on terminal elevator operations is not limited to one aspect or point of interface between the two systems. Any interaction between the two systems involves many facets of each system due to the interrelationship of the parts within each system. An analysis of the interactions between these two systems follows, commencing with a description of the information required. Following, the problems encountered during data collection are described. The concluding section of the Chapter covers an analysis of the interactions between the two systems.

A. Information Requirements and Sources

The first objective of this thesis was to determine and describe the effects of the Canadian grain grading system on the operational efficiency of the Pacific Coast terminal elevators. The second objective was to quantify the additional cost to terminal operations attributed to the current grain grading system. The final objective of the thesis was to determine the effect of increasing the number of grains and/or grades handled on terminal throughput. The three objectives are closely related and thus are covered in this Chapter.

To fulfill the first objective, it was necessary to obtain information on the structure and operation of both the grain grading system and terminal elevators, and to determine how they interrelate. Information concerning the grain grading system and terminal elevator operations was obtained through discussions with terminal elevator operators and other participants in the grain industry, review of published and unpublished literature, and on-site observation of terminal operations and grading procedures. The

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[152] Funk and Wagnall's Standard Desk Dictionary, 1982, p.686.

information gained with respect to the interaction of the grain grading and terminal operations was obtained through the same sources. Communication with terminal operators and industry participants, coupled with on-site observation of procedures, proved to be more informative than literature concerning this topic since literature was limited.

Fulfillment of the second objective required access to data concerning the operating costs for each of the terminal functions (described in Chapter IV) and determination of the extent costs were related to factors inherent in the present grading system. Due to data collection problems (discussed in the following section), operating costs for the different terminal elevator functions were not obtained. However, analysis of information provided by the Alberta Wheat Pool and other agencies allowed some of the effects of the grain grading system on terminal elevator operations to be quantified using proxies for costs. The proxies used included factors such as the time required for an operation, number of cars unloaded, turnover, storage space used and quantities of grain received or discharged. Although these proxies did not produce a cost figure in dollars spent, they did provide a measure of lost productivity due to the grading system.

Data required to fulfill the third objective consisted of information regarding the number of grains and grades received at the terminals and the time required to handle each of the grades. Although the information available did not allow a complete analysis, adequate information was collected to enable a partial analysis of these effects.

B. Data Problems

The analysis of the effects of one system on another involves numerous factors for which data must be collected. Several data criteria must be fulfilled to ensure that the analysis is valid. The two criteria used in this study to ensure the validity of the analysis were: 1) the sample data must be representative of the members of the industry, and 2) each member of the sampled group must provide similar data to allow all data to be compared and aggregated. Following is a description of the data collection problems which limited the scope of this study.

The first problem concerned establishment of a representative sample. Due to differences in their licensed capacity and age, none of the terminals were representative of any of the other terminals. The licensed capacities of the terminals ranged from 63,000 tonnes at Prince Rupert Grain Ltd. to 282,000 tonnes capacity at Alberta Wheat Pool. The age of the terminals ranged from 6 years (P.G.T.L. opened in 1979) to 69 years (P.E.L. opened in 1916).

Differences in age and licensed capacity of the terminals presented problems with respect to comparability and aggregation potential of the data. Due to factors such as level of technology, costs and demand for storage space at the time of construction, each terminal operates differently, rendering data comparisons of the six terminal elevators in the population infeasible. Although the operations performed on the grain are the same, the methods of performing the operations vary.

The six terminals on the Pacific Coast are managed by five different companies,[153] each using a different accounting system. The problems of using data from dissimilar accounting systems were outlined by French as follows:[154]

1. Unless the [illegible] system is highly standardized among plants, the costs compared may vary widely simply because of differences in accounting classification or allocation systems and the time of purchase of durable inputs.
2. Plant costs are affected by many factors, managerial efficiency, scale, production methods, input prices, degree of plant utilization, and random variation in plant performance.
3. Depreciation figures may vary owing to differences in accounting system, aquisition dates and depreciation rules that do not reflect the real input cost.
4. Accounting values are averaged for a period of time and may conceal variations in rates of output and plant utilization within accounting period.
5. Factor prices may vary among plants, owing to locational and institutional regulations and, over time, to price level changes.
6. Time series of long duration may reflect variations in the physical plant structure and production technique.

Owing to these factors a decision was made to limit the data collection to two Vancouver terminals, A.W.P. and P.E.L. Prince Rupert was excluded from the study very early due to two factors: 1) traffic through the P.R.G.L. terminal was lower and fewer grains were handled than through Vancouver, and 2) a new terminal was to be opened in 1984/85 which will replace the old terminal. Two Vancouver terminals were choosen for the following reasons: 1) both A.W.P. and P.E.L. are managed by A.W.P. and thus use the

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[153] A.W.P. owns 60 percent of P.E.L. and manages the terminal on behalf of S.W.P. and Manitoba Pool Elevators who own 30 and 10 percent, respectively.
[154] Ben C. French, "The Analysis of Productive Efficiency in Agricultural Marketing: Models, Methods and Progress" in *A Survey of Agricultural Economics Literature. Volume 1*, ed. Lee R. Marvin, (Minneapolis: University of Minnesota Press, 1977), pp. 123-126.

same accounting system. It was assumed that within the limitations of age and capacitys, they would be operated in the same manner, and 2) the two terminals represent more than 50 percent of the total licensed capacity in Vancouver and therefore should handle more than 50 percent of the grain exported through the port.[155]

Following the decision to limit the study to the two A.W.P. managed terminals, the next step was to obtain pertinent data. Three types of data were sought: 1) costs of the individual operations, 2) the volume of each grade of grain received and discharged each day, and 3) the time spent in each operation for the different grains and grades. To avoid aberations in crop production, historical data concerning the volumes of grains and grades received and discharged were to be collected. However, for several reasons usable data were not available.

Data pertaining to the costs of individual operations in the terminals were not available due to the nature of the acccounting system used by A.W.P. The A.W.P. terminal accounting system breaks costs into three main categories--capital costs, fixed costs and variable costs. Costs for a factor of production, such as power, for example, can be both a fixed and variable cost as the terminal pays a flat rate for power up to a set usage level and then a surcharge for power over that level.[156] Therefore, power cannot be proportioned among the various operations as there is no metering system in the terminal to determine individual usage. This problem was not limited to power use. Cost information was only available on an aggregated basis for individual factors of production used at the terminals and no objective method was available to proportion the factor costs to individual operations.

The tariffs charged by the elevator for the services performed provided a possible alternative means of assigning cost values to the individual operations. This solution proved to be untenable due to the method used by the Canadian Grain Commission for setting the maximum tariffs. Tariffs represent averages for all terminals in Canada and are not based on actual costs of individual operations such as elevation, storage, and cleaning. Rather they are based on the total costs of all operations per tonne.[157] It is

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[155] The other terminal operators in Vancouver were contacted in regard to the study. All three, S.W.P., U.G.G. and Pioneer, indicated that they would be willing to cooperate in the study and provide information.

[156] Personnal Communication, John Marchiori, A.W.P., Vancouver, February 1985.

[157] The Commission receives from all the terminal operators in Canada a statement of costs and revenues for the past two crop years. The costs are

uncertain whether the tariffs charged by an individual company reflect the actual costs of the services performed.[158] Therefore, tariffs were deemed unsuitable for use in this study.

Quantities of grains and grades received and discharged at the terminals were also unavailable in a usable form. The quantities of grains and grades received and discharged are reported daily. However, these daily reports are aggregated to produce a running crop year total-to-date. As the previous day's report is discarded, there is no record of transactions on a daily basis.

The third type of data, the times spent processing different grains and grades by each operation, were not available as records of this type are not collected at the terminals. However, some time information was available from time and motion studies carried out at P.E.L. and A.W.P. by Swan Wooster Engineering Ltd., a consulting engineering firm, for A.W.P. Although the information is not broken down by grade and grain, it does indicate the range of times required for performing certain operations. In addition, useful data were obtained from A.W.P. and other agencies, which assisted in partially quantifing the effects of the grading system on terminal elevator operations.

C. Analysis

The grain grading system has an impact on the terminal elevator operations system prior to the arrival of grain at the terminal. Interaction of the two systems occurs throughout the time the grain is in the elevator and concludes only when the grain is discharged and has received a Certificate Final. The magnitude of the effects of the grain grading system on terminal operations varies for different grains and grades and between operations. In addition, effects of the grading system on a terminal operation may be passed either backward or forward through the sequence of operations, subsequently

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[157](cont'd) broken down by factors of production in the terminal such as power, human resources and repairs, as well as other costs such as depreciation and administration. In addition, the submissions indicate the revenues of the terminal by area of receipt. In this way the Commission can determine the tariffs for the comming year.

[158] In the case of cleaning, this was confirmed by Mr. B. Friesen, A.W.P., Calgary. He stated that A.W.P. had requested an increase in the maximum tariff for cleaning but when asked by the Commission to prove that the increase was justified A.W.P. was unable to do so as the cost of cleaning a tonne of grain was not known and could not be determined from the records which were kept.

affecting other operations.

An analysis of the effects of the Canadian grain grading system on the operations of Pacific Coast grain terminal elevators is presented below followed by analysis of the effects of the terminals handling additional grains and/or grades. The analysis for the most part follows the sequence of operations in order of occurrence. However, due to the interrelationship of terminal operations, the effects on some operations may be discussed out of sequence.

Receiving Operations

Car Arrivals

The order in which grain cars arrive at the terminals may be postulated to be a result of the grain transportation system rather than the grain grading system. However, this is not necessarily the case. As outlined in Chapters III, IV, and V, grain received at the primary elevators is assigned a grade for the purposes of paying the producer and for storing and loading it with other parcels assigned the same grade. The grade assigned at the primary elevator is not an official grade and as such has no purpose other than the two described above.

Grain is loaded into a rail car on the basis of the elevator assigned grade and becomes one parcel of grain of the same grade. The loaded cars are moved from the primary elevators along the branch lines to a major center such as Calgary or Edmonton. Cars are assembed into trains and are moved to the Pacific Coast, where the cars are stored in one of the railyards until shunted to the terminals.

As the grade assigned to the grain at primary elevators is not an official grade, there is limited effort expended at the major Prairie centers to keep cars of the same grade and grain together as a group. Thus, the sequence of car arrivals is not planned on the basis of grade. This is a function of both the grain transportation system and the grain grading system.

The sequence of car arrivals was brought foward as a problem at the terminals in the *Pacific Coast Study*[159], (see Chapter II). The study found that 69 and

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[159] Canada Grains Council, *Pacific Coast Study* (Winnipeg: C.G.C., 1976).

72 percent[160] of the cars arriving on the two days monitored were single lots. The Swan Wooster study, carried out for A.W.P. in 1982/83, found single lot car arrivals occurred 38 and 32 percent[161] of the time at A.W.P. and P.E.L., respectively. Although there has been an improvement in the number of multiple lots arriving at the terminals, there is still approximately one car in three which contains a different grain or grade than either the car ahead or the car behind.

Comparing the rated capacity of car unloads per shift with the estimated average number of cars unloaded provides an indication of the effect of the sequence of car arrivals at the A.W.P. terminal. The G.T.A. lists the rated car unloading capacity of the A.W.P. at 90 cars per 8 hour shift.[162] In comparison, A.W.P. estimates an average of 70-75 cars unloaded per shift.[163], a difference of 15-20 cars (16.6-22.2 percent) or 1185-1580 tonnes[164]. The A.W.P. operates 3 unloading shifts per day, 5 days a week, for approximately 260 days per year. The difference in unloading capability between the G.T.A. figures and the A.W.P. average equates to 924,300 tonnes to 1,232,400 tonnes per year. These estimates assume that the grain cars are available for unloading.

During crop year 1983/84, A.W.P. experimented with unit trains of mustard seed and durum wheat consisting of greater than 100 cars. The unloading rates for these two unit trains were 100 and 105 cars per shift, an increase of 1,975 to 2,765 tonnes (35.7 to 46.7 percent) per shift over the average tonnes unloaded.

UNLOADING AND GRADING

Under the present grading system, a terminal elevator operator is unaware of the official grade of grain arriving in a car. Consequently, the grain must be sampled and graded from the first draft[165] before any operations can be performed. Once the official grade has been determined, the distribution system can be set to deliver the

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160 *Ibid.*, p.163.
161 Unpublished A.W.P. internal information.
162 Canadian Transport Commission, Untitled, Vancouver, 1981, (Mimeograph).
163 Personnal Communication, John Marchiori, A.W.P., Vancouver, February 1985.
164 The average car weight received at A.W.P. is 79 tonnes.
165 Due to the size of the scale, hopper cars loads are elevated in two segments or drafts. Each draft is approximately 35-50, tonnes depending upon the weight of the grain in the car. The size of the scales reflects the time of construction, as 35-50 tonnes capacity was large enough to weigh a box car load of grain.

grain to the appropriate bin in the workhouse or one of the annexes. Delivery of grain from the scale to a workhouse bin involves setting the mayo, a spout which directs the grain to the appropriate bin. Alternately grain which is to be delivered to one of the annex bins requires both a mayo and an annex tripper be set to move the grain onto the appropriate bintop conveyor which conveys the grain to the designated annex bin.

The Swan Wooster time and motion study at the A.W.P. terminal found that the average time required to sample and grade a car of grain was four minutes. Distributing grain to the workhouse and annex bins averaged three and seven minutes, respectively. Consequently, the average total car cycle times[166] were 11.2 minutes for grain directed to the workhouse and 18.2 minutes for grain directed to the annex.(see Figures VI-l and VI-2)

Official grading of grain on the Prairies and receipt of large lots at the terminal would not reduce the car cycle times by the four minutes spent grading and the three or seven minutes spent setting the distribution system since other operations, such as filling and emptying the scale also require time. As the grading operation is carried out during the elevation and weighing of the first draft only part of the time spe[illegible]ding delays the car cycle. The average waiting period (slack) for the grading to[illegible]mpleted and the distribution system to be set was between 2.5 and 3.8 minutes per car, depending on whether the grain was directed to the workhouse or an annex. If the grain received at the terminal had been graded previously and the terminal operator was aware of the grades being received, the setting of the distribution system could begin as soon as the previous car load of grain had cleared the system. This would result in some time being saved. Removal of the slack period by having the grain graded prior to receipt at the terminal would reduce the car cycle times to 8.7 minutes for grain directed to the workhouse bins and 14.4 minutes for grain delivered to the annex. In addition, the Swan Wooster study found that 60 percent of the car loads were directed to workhouse bins and 40 percent to the annexes. Using the 60:40 ratio, the average car cycle time for all

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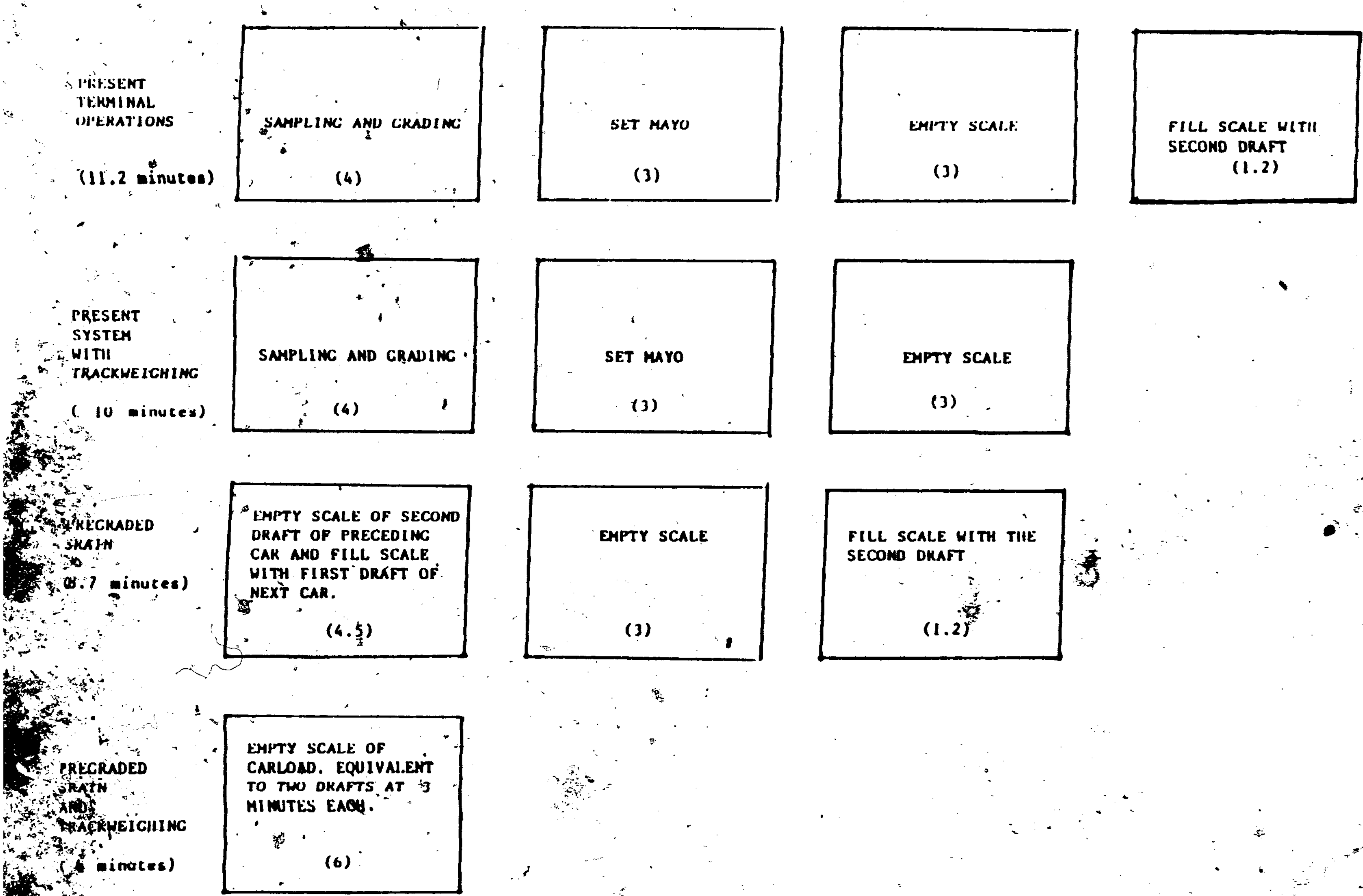
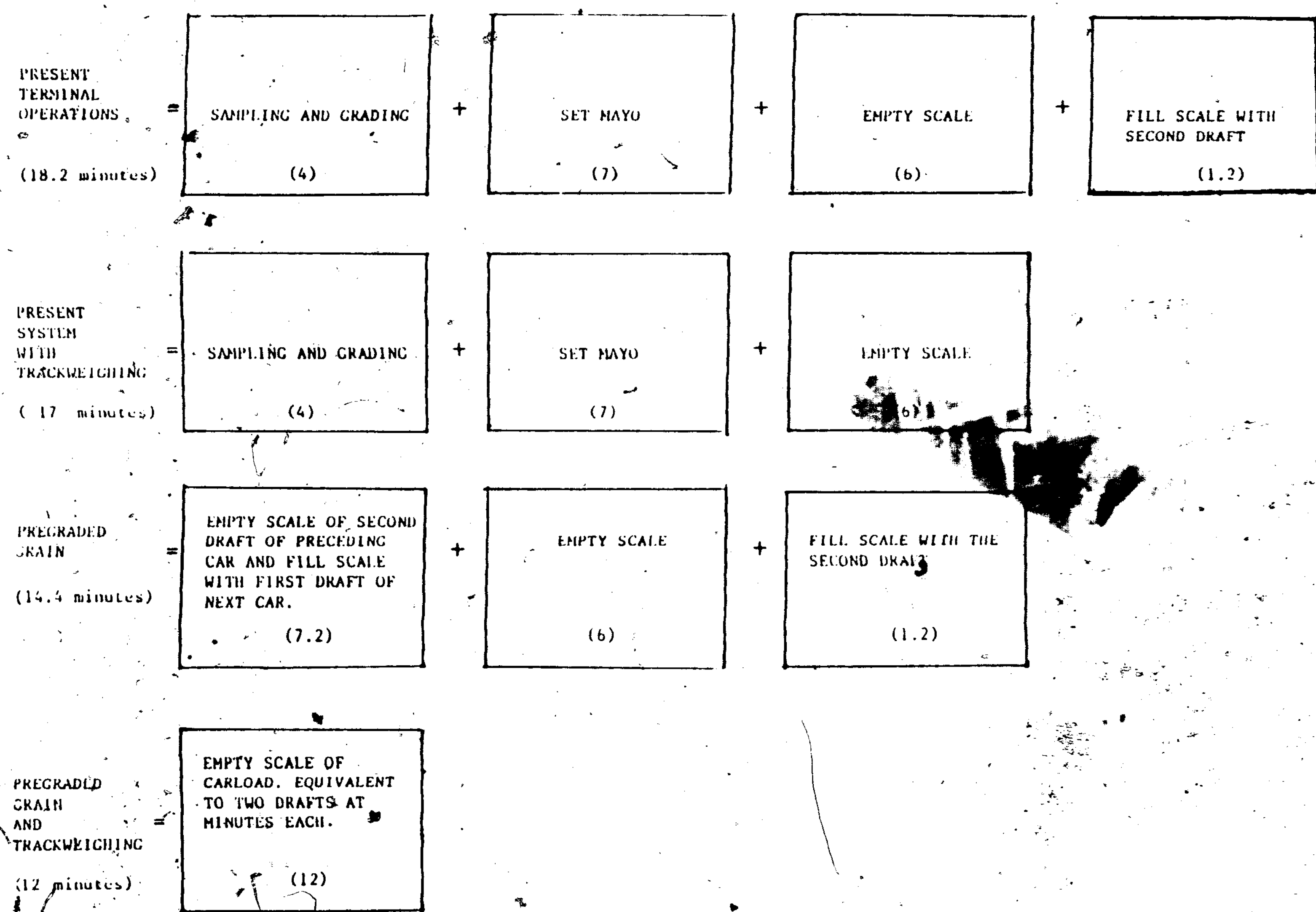
166 A car cycle is the time period between cars being unloaded. The cycle begins with the start of a car being unloaded and ends with the unloading of the following car.

Figure VI-1 Workhouse Bins Critical Path Scenarios.



Source: Scenario times summarized by author.

Figure VI-2 Annex Bins Critical Path Scenarios.



Source: Scenario times summarized by author.

cars is reduced from 14 minutes,[167] to 10.98 minutes,[168] a potential increase of 27.5 percent in unloads.

Two methods were used to determine the effect grain officially graded prior to receipt at the terminals could have on the potential number of cars unloaded:

Method 1 Based on the 27.5 percent increase in unloads and the A.W.P. estimate of 70-75 cars[169] unloaded per shift, unloads could potentially increase by 19-20 cars or 1501-1580 tonnes per shift.

Method 2 Assuming that there are no external problems such as availability of cars which reduce the potential of the receiving system, the potential number of cars which could be unloaded is 114 per shift.[170] The difference in the estimated average number of cars unloaded per shift at present (A.W.P.) and the potential number of cars which could be unloaded (114) is 39 to 44 (a 52 to 62.8 percent increase).

Increasing the number of cars per lot delivered to the terminals could also result in a time saving, increasing potential unloads. The arrival of cars in large lots would reduce the number of times the distribution system needed to be reset during the shift. This would reduce the average time spent per car, thereby increasing the potential number of unloads per shift.

The potential increases in car unloads resulting from 1) pre-graded grain and 2) delivery of grain cars in large lots of the same grade would be difficult to achieve, due to other limiting factors such as cleaning capacity and storage. In order to accomplish the above mentioned potential increases through to pre-grading cited above, an additional 45 (Method 1) to 132 (Method 2) cars would have to be delivered to each terminals daily. If all five terminals in Vancouver increased their car requirements accordingly, approximately 200-600 additional cars per day would

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[167] Calculated as follows: (18.2 minutes x .4) + (11.2 minutes x .6)= 14 minutes.

[168] Average car cycle after removing the slack was calculated as follows:(14.4 minutes x .4) + (8.7 minutes x .6) = 10.98 minutes.

[169] The estimate of 70-75 cars unloaded per shift was obtained from A.W.P. Vancouver and is independent of the Swan Wooster study.

[170] Under this assumption, the number of cars which could be unloaded during a shift at present is (7 hours x 60 minutes /hour x 3 receiving systems) / 14 minutes/car cycle =90 cars per shift, exactly the G.T.A. rated capacity. The potential rate of 114 cars per shift is calculated the same way but substituting in 10.98 minutes for 14 minutes per car cycle. Both calculations assume that the receiving systems shut down for one hour per shift for meals.

have to be delivered to Vancouver. This would put added strain on the rail system, if in fact the cars and grain needed to fill the cars were available on the Prairies.[171] Other terminal operations also place constraints on the receiving operation. Both the cleaning system and the amount of available storage space limit the number of cars which can be received.

Cost savings could result from a reduction in human resource costs. An increase of 27.5 percent (Method 1) in unloading cars would allow for the reduction of one shift in every five. As each shift consists of 2-3 crews of 4-5 men each, a reduction of one crew per day would save approximately $160,000 to $200,000 a year.[172] Achievement of the unloading potential of 114 cars per shift could eliminate one complete receiving shift per day while maintaining an average of 228 unloads per day. Assuming 3 crews per shift, this would reduce labour costs $480,000 to $600,000 a year. Additionally, an increase in the number of cars unloaded per shift could reduce the amount of overtime required, perhaps making weekend shifts unnecessary.

Grading at the terminals has effects on the receiving operation other than the time which is spent to perform the actual inspection. The lack of information concerning the grade prior to receiving means a decision is required on where to direct the grain upon receipt of the grade assignment. This prevents the terminal operator planning the daily operations in advance. The lack of foreknowledge of grades being received also results in the terminal receiving grades which were not expected.[173] The terminal operator must often change plans to accommodate the unexpected grain which may result in delays.

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[171] Assuming these measures could speed up the turn around time to 10 days. An increase of 200 cars per day would require an addition of 2000 cars to the grain fleet.

[172] A.W.P. estimates the cost per hour of one worker is $20.00 including benefits. On the basis of a 40 hour work week and 52 weeks per year, this amounts to $41,600 a year per worker.

[173] For example, this occurred in June 1984, when wheat shipped from the Prairies as No. 3 C.W.R.S. was graded No. 1 C.W.R.S. at the terminal. Occurrences such as this cause problems for the terminal operator as plans have to be changed to accomodate unexpected arrivals. In addition, problems are caused for the C.W.B. as an occurrence such as this may result in not enough of the required grade being on hand to meet sales commitments.

Weighing

Weighing is supervised by a weighman of the Weighing Division, Canadian Grain Commission. The operation entails filling the scale hopper with each draft, taking the weight and then emptying the hopper. The Swan Wooster study estimated an average of 1.2 minutes per draft was spent filling the scale hopper. Time expended emptying the scale averaged 3 minutes per draft for workhouse grain and 6 minutes per draft for annex grain. The time is greater for annex grain since a lower rate of discharge from the scale is required as it is loaded onto a conveyor belt rather than into a bin. A higher rate of discharge causes grain to bounce off the conveyor and requires additional labour for clean up.

The present system of grading the grain at the terminals allows ample time for the scale hopper to be filled for the first draft. However, the time required to fill and empty the second draft occurs after the grade has been assigned and the route set. The second draft weighing operation thus increases the time per car cycle.

An alternative method of weighing grain would be track weighing.[174] This method would reduce the car cycle times by eliminating the necessity of elevating two drafts. The total carload could be elevated into the existing scale hopper and scale garner and held until the grade was assigned.[175] The total time required to empty both the scale garner and the scale hopper per carload would be 6 minutes for workhouse grain and 12 minutes for annex grain (see Figures VI-1 and VI-2). The time saving would only be the 1.2 minutes required to fill the scale with the second draft as the first draft is filled during the terminal grading operation. The use of track weighing under the *present grading and car arrival system* could result in an 8.57 percent increase in car unloads (approximately 6 cars per shift).

A change in the location of grading or the arrival of larger lots would make track weighing a more tenable operation. Although either of the improvements would reduce the car cycle time, the reduction in time required to set the distribution

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[174] Track weighing consists of having a track with a built in scale over the receiving pit. The loaded hopper car is weighed, the grain is discharged and the car is weighed empty. The difference in weights is the weight of the grain received. A similar system is used at primary elevators for weighing grain delivered in farm trucks.

[175] The rate of flow from the garner into the scale hopper is faster than the flow out of the scale hopper, thus flow out of the scale hopper would be the limiting factor.

system for large lots is difficult to ascertain. However, the effects of pre-graded grain and track weighing can be analyzed using the Swan Wooster time and motion study.

Assuming that the receipt of pre-graded grain at the terminal eliminates the time required for grading and allows the terminal operator to pre-plan the grain distribution, the weighing operation becomes the limiting factor in the receiving operation. Track weighing would eliminate the time required to fill the scale with both drafts(2.4 minutes as grading would not be the limiting factor on the 1.2 minutes for the first draft), thus the faotor limiting the car cycle under track weighing would be the time required to empty the system of the total carload. Using the average times estimated by Swan Wooster, the total car cycle time required under track weighing would be 6 minutes for workhouse grain and 12 minutes for annex grain. The average car cycle time using the 60 percent workhouse, 40 percent annex distribution would be 8.4 minutes. This results in an additional 23.5 percent reduction in the average car cycle time from the above 10.98 minutes potentially achievable from *receiving pre-graded grain*. Both pre-grading and track weighing could potentially raise the car unloads to 50 cars per receiving system or 150 per shift, an increase of 75-80 cars over the estimated average unloads at present (A.W.P.).

Conversion to track weighing at the terminals could increase the number of car unloads per shift. However, track weighing would first need to be incorporated into elevator plans and amortized capital costs determined. Similarly, decreases in elevator variable costs through reduction in overtime shifts on weekends would need to be assessed relative to investment costs.

The use of origin weights, as in the U.S., is a possible alternative to the present weighing system at the terminals. As there are few inland terminals in Western Canada, this system would require using the loading weights from the primary elevators. However, unlike grading, weighing can be quickly accomplished at the terminals using track weighing. Thus a shift to using origin weights may not be advantageous to the Canadain grain industry as the cost of ensuring scale accuracy at the primary elevators could exceed the cost of installing track weighing at the terminals.

Cleaning

Cleaning grain at the terminals is a function of three factors: 1) the Western Canadian climate, which necessitates swathing prior to harvest thereby increasing the amount of foreign material in the grain; 2) the high capital cost of cleaning equipment for various grains which deters the installment of cleaners at primary elevators; and 3) the Canadian grading system's high quality standards and relatively low tolerances for foreign material in grain. These three factors result in the major responsibility for cleaning Prairie grain being placed upon the terminal elevators.[176]

At present, grain is delivered to the cleaners by one of two methods. It is either conveyed directly into a cleaning bin from the scale or transported from the annex back to a cleaning bin. Once the grade is known, the terminal operator can direct the carload into a cleaning bin holding that grade for cleaning. Conversely, grain directed to the annex is temporarily stored in a bin until either there is room in the cleaning bins or the cleaners are engaged in cleaning that type of grain. The delivery of grain directly to the cleaning bins from the scale requires a smaller expenditure of time and labour than routing grain to the annex and subsequent retrieval for cleaning.

The Swan Wooster study estimated that 60 percent of the grain went the workhouse route and 40 percent the annex route. The estimated distribution for carloads routed to the workhouse and the annex was based on the average number of carloads received per day during the study period. An increase in unloads due to changes in the receiving operation could render the 60-40 distribution invalid. Currently, uncleaned grain is routed to the annex due to limited space in the cleaning bins. An increase in unloads per shift would further increase the amount of grain which would be routed to the annex.

The cleaning bins in the workhouses of the elevators studied were constructed prior to the advent of hopper cars. As a result, the bins were designed to hold box car loads rather than hopper car loads of grain. The bin sizes for the wheat cleaning system at A.W.P. vary from 109 tonnes to 191 tonnes capacity. The 109 tonne bins can hold one

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[176] Some of the new high throughput primary elevators have the capability for cleaning some but not all types of grain. The inland terminals have also cleaning systems. These elevators ship cleaned grain to the Port terminals. However, the bulk of the grain received at the Pacific Coast terminals is not cleaned.

hopper car load of grain or two box car loads. The 191 tonne bins can hold two hopper car loads, but due to the nature of the sequence of arrivals and lack of pre-grading, sometimes contain one carload. The number of bins per cleaner varies from three to eight, limiting the number of carloads of grain which can be routed directly to the cleaning bins.

The grain from each cleaning bin is processed through the cleaners as a batch. The grain is sampled to ensure that a sufficient amount of foreign material has been removed by the cleaners to meet export standards. To allow time for the sampling process, the first 10-15 percent[177] of the grain processed is recycled into the cleaner. This ensures that inadequately cleaned grain is not mixed in with grain which is clean. Once the cleaner bin is empty and all the grain has been processed through the cleaner, a new bin of grain is discharged into the cleaner.

The cleaning rate for the wheat cleaners was measured by A.W.P. to be 128 tonnes per hour (approximately 1.6 carloads). However, due to the switching over period between bins cleaners and adjustments which must be made ot the cleaners, an average set-up time of 12 minutes per bin load is required. The set-up time could be reduced if the terminal operator was aware in advance of the grades being received. Allocation of the same wheat grade and protein content to the cleaner could allow for a more continuous flow, thus reducing the set-up time. The set-up time could not be eliminated entirely as time is required to shift the cleaner spout from bin to bin and also switch the distribution system once an annex bin is filled.

A reduction in the average set-up time from the present 12 minutes to 6 minutes[178] could increase throughput of the cleaners by 16 percent,[179], an increase of 20.48 tonnes per hour or 143.3 tonnes per shift. This increase could partially accomodate an increase in the unloads potentially achievable through pre-grading, track weighing or receipt of cars in large lots.

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[177] Swan Wooster, time and motion study, Unpublished A.W.P. Internal information.

[178] Calculated by using the average mayo setting time of three minutes per carload for receiving cars of grain for the workhouse and assuming that the advantage of foreknowledge of grade would reduce the time of setting the annex system to six minutes from the seven required for the present receiving system. As annex bins are larger than workhouse bins it was assumed that the distribution system to the annex would only have to be set once for every two carloads cleaned, an average of three minutes per car.

[179] Calculated as follows: 1.6 cars/hour x 6 minutes saved =9.6 minutes per hour, 9.6/60 minutes/ hour = 16 percent.

The problems incurred in attempting to reduce set-up times by allocating certain grades to specific cleaners are compounded by protein segregations. As some wheats are sold on the basis of grade and protein content, the protein levels within each grade must be handled separately. There are nine possible protein segregations in the three grades of Hard Red Spring Wheat. Although not all nine are used in every crop year, protein levels generally require six or seven distinct segregations in the Hard Red Spring Wheats rather than the three which would be required on the basis of grade alone. Difficulties in segregating grades increases with the number of protein levels due to shortages in available cleaners and in the future could have a detrimental effect even if cars arrived carrying pre-graded grain as the number of grades and protein segregations is greater than the number of available cleaning sections.

Rigid standards exist regarding the required cleanliness of grain. These standards make cleaning one of the most important terminal functions. Once the grain has passed through the cleaners and is delivered to the annex for storage, the grain is not officially inspected until it is shipped. Grain which does not meet export standards during shipping is removed from the vessel at the terminal operator's expense.[180] The possibility of additional expenses being incurred at the time of shipping ensures that terminal personnel carefully monitor the grain cleaning operation.

The result of improper cleaning can be either overcleaning or undercleaning. In overcleaned grain not only is the foreign material removed but also some of the grain. Overcleaning results from machines running too slowly or being improperly set. If the machines operate too slowly, the cleaning rate is also reduced.

Undercleaning occurs when the cleaners are improperly set or are running too fast. As a result, too little foreign material is removed from the grain. Undercleaned grain must be recleaned; otherwise the foreign material present will exceed the export tolerances. Both undercleaning and overcleaning result in additional costs for the terminals.

The tolerances for allowable foreign material often result in grain being cleaned twice. Swan Wooster found that during their study period, 73 percent of the Hard Red Spring Wheat and Alberta Winter Wheat and 17 percent of the durum wheat required two

[180] Alternatively, if the customer is willing, the grain is sold at a lower grade and the difference is paid by the terminal operator.

passes through the cleaners. As Hard Red Spring Wheat constitutes the majority of the wheat handled at A.W.P., a 73 percent recleaning requirement places a large burden on cleaner throughput.[181]

Grains other than wheat also require more than one pass through the cleaners. In fact, some carloads of grain arrive at the terminals requiring three or four passes through the cleaners to remove dockage. Consequently, less than 128 tonnes of grain in wheat equivalents are cleaned per hour.

Part of the problem may be attributed to the fact the the C.G.C.'s Grain Inspection Office uses small samples and small cleaners to assess the amount of foreign material in the grain. The terminals use large commercial cleaners and work with 79 tonne batches of grain. The difference in the magnitude of the equipment and parcels of grain often results in discrepancies between the two, resulting in, the terminals cleaning batches of grain more than once.

Cleaning is one of the major bottlenecks in terminal operations. A general "rule of thumb" for labour requirements at the terminals is two shifts receiving, three shifts cleaning and one shift shipping.[182] The cleaning operation, therefore, limits the potential for increasing the throughput of the terminals. Under the present grading system, the terminals tend to overclean the grain as it is easier to overclean and then recover the grain through a reclaiming system than it is to reclean.[183] In addition, overcleaning reduces the risk of having to unload ships due to excess foreign material content.

Unintentional overcleaning also occurs due to the sales contracts for C.W.B. grains. Often these grains are sold on the basis of grade, protein level (where applicable) and dockage. Cleaning the grain to meet export standards, which is frequently higher than that specified on the contract, often results in a lower dockage level than required. If this occurs either the customer receives more actual grain than he paid for or the terminal operator is forced to blend in screenings to bring the dockage close to the allowable amount. The former case results in lost revenue to Canadian producers, as less grain is available for export. The latter situation means that the terminal operator runs the risk of

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[181] These three types of wheat comprise an average of 72.2 percent of the grains using these cleaners. The requirement for 2 passes reduces cleaning capacity by a minimum 54.1 percent.
[182] Personnal Communication, John Marchiori, A.W.P., Vancouver, February 1985.
[183] Personnal Communication, David Ball, A.W.P., Calgary, May 1985.

adding too much dockage, resulting in additional costs. Either way, there is a loss in efficiency as cleaning capacity has been reduced due to overcleaning which is a result of the present grading system.

Several methods exist for increasing the cleaning capacity of the terminals. The receipt of pre-graded grain, discussed earlier, could allow for better planning and result in reduced set-up times for the cleaners. Other possibilities include: 1) adding extra cleaning shifts, 2) increasing the number of cleaners, and 3) increasing the foreign material or dockage content acceptable in export grain.

The first two alternatives involve increasing costs at the terminals. Costs which may be passed back to the producer. In addition, both of these alternatives may be infeasible. Increasing the number of shifts worked on the cleaners is limited by the number of cleaners and the number of days in a week. Costs per tonne for cleaning would also increase due to added overtime payments.

Expansion of the number of cleaners at the terminals is limited by the space available. Most of the terminals have as many cleaners as their present space permits. Also, increasing the number of cleaners would require additions to the workhouse--bins would have to be constructed and transportation and other systems installed. The large capital expenditures required would need to be capitalized over several years, increasing rather than decreasing the cost of operations at the terminals.

Increasing the allowable amounts of foreign material and dockage would increase the cleaning capacity by reducing both overcleaning and the requirement of two or three passes. It could be argued that allowance of increased dockage may cost producers in the long run if Canada's reputation as an exporter of clean, high quality grain is diminished. However, the fact that addition of dockage is required to bring dockage levels up from export standards to contract sale levels indicates that the tolerance levels could be changed.

Storage

Storage space at the terminals serves two purposes, 1) temporary storage of grain requiring processing such as cleaning or drying, and 2) storage of processed grain awaiting shipment until large enough parcels are accumulated. Grain awaiting processing is stored in bins generally located in the workhouse, whereas grain for shipment is stored in one of the annexes. Frequently, the limited amount of workhouse storage space requires some annex bins to supplement temporary storage of grains in the workhouse. Conversely, workhouse storage space is used for storing processed grain during the infrequent times when the elevator is plugged.[184] As the effect of the grading system on workhouse storage was described in the cleaning section, the following section focuses primarily on the storage in the annexes.

The A.W.P. terminal, the largest on the Pacific Coast, has a total annex storage capacity of 256,259 tonnes. This storage capacity is in the form of 467 bins ranging in size from 103 tonnes to 2,250 tonnes, located in four annexes. However, not all of the storage capacity in the annexes can be fully utilized.

The Pacific Coast Study estimated that the proportion of space used to space available ranged from 46.7 percent to 64.1 percent between crop years 1971/72 to 1975/76.[185] There are several reasons for less than 100 percent utilization of available storage space. One reason is the use of annex storage space for grains awaiting processing. Other causes may be attributable to the present grain grading system in Canada.

Grading at the terminals requires that the grain be dumped, elevated and weighed prior to the official grade being assigned. The terminal operator has no control over the grade of grain which he receives. Therefore, cars of unwanted grains or grades which should have gone to another terminal are received at his terminal. The terminal operator must accept, clean and store this grain. If the grain is a grade the terminal does not normally handle, it must be binned separately. This means that one bin has to be used for only one carload of grain. In addition, off-grade grain--grain which is down graded on the basis of factors such as, damage, stones, poor quality and pesticide residues--must be binned separately. The terminal operator cannot reject these carloads of grain and, therefore, must store them until a market can be found.

Off-grade and misshipped grains tend to be stored longer than the regular grades handled by the terminal. The average turnover time for the regular grades is approximately

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[184] Plugging occurs when the elevator has no space available to receive more grain.

[185] Canada Grains Council, *Pacific Coast Study* (Winnipeg: C.G.C., 1976), p.167.

30 days, whereas the turnover time for off-grades is estimated to be 60 days.[186] Some of these off-grades are sold "as is" to customers, while other parcels are blended with high quality grain prior to shipping. Some of these grains can neither be sold or blended due to extremely low quality or the presence of pesticide residues (usually mercury seed treatment). Poor quality grains may be shipped to the pelleting plant and the loss absorbed by the terminal operator. However, the grains containing pesticide residues cannot be used for food or animal feed and must be stored indefinitely, thus removing the bin from service for long periods of time.[187]

The result of having to store off-grades and condemned grains is that the total storage space in the terminal turns over about 10 times per year rather than the 12 times possible using the 30 day average.[188] This results in a loss of approximately 500,000 tonnes which could have been handled if the space was not being used for non-desirable grains. For every 10,000 tonnes of space used for off-grades, the elevator throughput is reduced by a further 10,000 tonnes.

Although, the volume of these off-grades is relatively low compared to the volumes of regular grade grains stored at the terminals, a major problem arises from the fact that each off-grade grain must be binned separately. Consequently, in addition to terminal capacity the numbers of bins available is critical to efficient operation. During crop years 1981/82 and 1982/83, both A.W.P. and P.E.L. shipped an average of 21 different grades of grain.[189] The number of grades listed at P.E.L. in January 1984 was greater than 80.[190] Therefore, more than three times as many grades were stored as were shipped during the previous crop year. This means that an estimated 3 percent of the volume stored utilizes 20 to 25 percent of the storage space in the terminal.[191]

The plethora of grades in the Canadian grain grading system allows grain to be segregated on the basis of small differences in quality characteristics. This affects

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[186] Personnal Communication, John Marchiori, A.W.P., Vancouver, February 1985.
[187] Even if these condemned grains can be removed and subsequently destroyed, the terminal is required to thoroughly clean the bin and the system used to remove the grain.
[188] During crop years 1980/81 to 1983/84 A.W.P. turnovers ranged from 8.6 to 12.2 with an average annual turnover of 10.5.
[189] Nineteen grades were shipped from A.W.P. and P.E.L during 1981/82 and and 23 in 1982/83, an averaging of 21 per terminal for the two years.
[190] P.E.L. weighover report January 1984. Of these more than 80 grades, 11 were either rejected or condemned grades.
[191] Personnal Communication, David Ball, A.W.P., Calgary, May 1985.

storage as high volume regular grade sales are based on grade and protein segregations. The greater the number of segregations, the longer the time required to build up shipable stocks. The average parcel size of grain shipped from A.W.P. and P.E.L. during crop years 1981/82 and 1982/83 was 7,566 tonnes (approximately 96 carloads per parcel). The time required to build up the average parcel size varies between grains.

Elevator plugging is a result of several factors such as, space being utilized by off-grade grains, small parcel sizes of various regular grade grains, shipping delays and lack of export sales. The elevator is unable to receive cars while plugged as no space is available for the new grain. This results in the elevator losing potential throughput as the cars allocated are shunted to other terminals. Therefore, costs per tonne of grain handled could increase, as fixed costs remain the same while revenues from receipts are reduced. The plugged situation can only be alleviated by discharging grain onto a ship. However, if the parcel sizes of the desired grain are not large enough at the plugged terminal, the ship is directed to another terminal. Thus the plugged condition is prolonged.

Storage space is one of the major limiting factors in terminal elevator throughput. Space is required for grains which must be processed, grains which await shipping and grains which have been received but for which there is no market. Storage space problems at the terminal could be rectified through construction of additional annexes. However, due to space limitations at the port and expense, this is not feasible. Additional annexes at the terminals would not increase the turn over rate as there would more space to turn over. The Churchill elevator for example, which receives few grades of two types of grain (wheat and barley) averaged a turn over of 4.8 in 3 months.[192] Turn overs at the Pacific Coast terminals of 10.9 over 12 months[193], could be increased if the number of grades received was reduced. Alternatively, if pre-grading was performed, the operator could reject grades which adversely affect storage space.

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[192]Canada Grains Council, *Exporting Grain Through the Port of Churchill: A Capacity, Cost and Systems Analysis.*(Winnipeg: C.G.C., 1981), p.47.
[193] *Ibid.*, p.47. The actual 1980/81 to 1983/84 average turn over for the Port of Vancouver terminals was 10.7 and ranged from a low of 9.1 to a high of 12.06.

Drying and Fumigation

Grain drying is required if the grain is received in a damp, moist or wet condition since excess moisture causes deterioration. Tough grain[194] can be blended with dry grain without a loss in the value to the dry grain. In fact, blending tough grain allows the terminal to gain drying revenues without actually drying the grain, a process known as paper drying.

A.W.P. and P.E.L. do not find drying a problem. Conversely, S.W.P. in Vancouver indicated that drying was a problem. The difference between A.W.P.'s and S.W.P's perceptions is a result of the grain received. A.W.P. receives grain on the C.P. track while S.W.P. receives grain from the C.N. line. C.N. services the northern part of the Prairie production area where the harvesting season tends to be shorter. Consequently, grain arriving at Vancouver on the C.N. line has a greater probability of being graded tough, damp or moist. As. S.W.P. receives the majority of cars delivered from C.N., due to car pooling, drying may be a problem.

Fumigation is required when insect-infested grain is received. Allowing the infested grain to be stored without fumigation could result in deterioration of the grain and a spread of the insects throughout the terminal. Fumigation is a simple operation of metering phostoxin pellets into the grain during transportation to a bin. The bin is sealed and the pellets give off a gas which kills the insects. Following the treatment, the grain is inspected by Agriculture Canada entomologists. If the insects are dead, the grain can be processed.

Fumigation is not often required, and therefore does not place a strain on elevator operations nor does it adversely affect terminal throughput.

Shipping

The final operation performed by terminals is the loading of shipping vessels. Shipping requires that clean, dry grain of the correct grades be on hand to satisfy the contract requirements for the vessel. The grading system, therefore, affects shipping indirectly rather than directly.

Grain shipped from the terminal is sampled and graded by an inspector of the C.G.C.'s Inspection Division during the loading operation to ensure the grain meets export

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[194] Tough grain is grain which contains more moisture than the grade allows but is less than the amount required to be graded damp.

or contract, standards. Grain not meeting these standards is either unloaded from the ship or, if the customer is willing sold on the basis of its quality. The terminal operator pays for either the unloading operation or the difference in the selling price to the C.W.B. Grain may not meet export standards due to three factors 1) inadequate cleaning, 2) blending too much dockage or lower quality grain into the higher quality grain to fill contract requirements, and 3) the difference between the primary standards and the export standards. The first two factors have been described previously in the cleaning and storage sections. The third factor is due to the manner in which grain is graded.

Grain is received at the terminals on the basis of the primary standards. These standards represent the minimum quality factors acceptable in the grade. Conversely, most Board grains are shipped from the terminals on the basis of export standards which represent the average quality in the grade. Export standards apply to 19 grades of wheat (Red Spring, Soft White Spring, Utility, Feed and Durum), barley and oats.[195] These grades represent more than 50 percent of the tonnage and number of parcels shipped from A.W.P. and P.E.L. As terminals generally receive grain delivered by one railway only, the quality of the grain reflects the climate of either the northern or southern Prairies. Although grain may meet the primary standards when received, the quality of the parcel may not be sufficient to meet export standards. Therefore, the terminal operator requires a wide range of quality within a grade in order to blend to export standards. The terminal operator is thus responsible for problems beyond his control.

The difference between primary and export standards have been compounded by the fact that there is no representative from Vancouver on the Western Standards Committee.[196] Thus the Vancouver terminals must operate using standards which are set by others not familiar with the situation at the terminals on an on-going basis.

Shipping problems associated with parcel sizes and elevator plugging have been discussed previously. However, parcel sizes affect total shipping for the port,[197], not just the individual terminal. Small parcels of grains in the terminal may lead to demurrage charges if a vessel is required to wait until adequate stocks are built up. Demurrage

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[195] Canadian Wheat Board, *Canadian Grains Handbook 1982/83 Crop Year* (Winnipeg: C.W.B., 1983), pp.10-13.
[196] Personnal Communication, John Marchiori, A.W.P., Vancouver February 1985.
[197] Small parcels at all the terminals require a ship to move from terminal to terminal to acquire the contracted amount.

charges incurred are subsequently passed back to the producer.

The grading system is not responsible for all demurrage charges as some are incurred due to insufficient producer deliveries to the primary elevators. This situation arises 1) when the domestic price exceeds the export price, or 2) when Prairie stocks are low.

Shipping operations are constrained by the other terminal operations. Changes to the grading system which would reduce the number of grades and the export standards could decrease the costs of shipping. However, at present shipping requires the least labour of the three active operations--receiving, cleaning and shipping. Changes which increase the ability of the terminal to receive, clean and store grain will result in shipping cost reductions.

D. The Effect of Additional Grades on Terminal Operations

Additions to the numbers of grades in the grading system occur periodically due to changes in agronomic pratices. The effect of additions to the number of grains and grades handled by a terminal is shown in Table VI-1 below. The analysis used the Alberta Wheat Pool terminal in Vancouver as a benchmark in order to be as realistic as possible. Two assumptions were maintained throughout the analysis; 1) receiving operations were not limited by the arrival of rail cars, and 2) ships were always available. Analysis of the addition of grades was accomplished using scenarios commencing with one grain or grade of grain being received at the terminal and ending with seven grains and grades being received. Three segregations of grains were used in this analysis, wheat, barley and other grains. The general category of wheats was then further segregated into three classifications of wheat, Hard Red Spring Wheat, Red Winter Wheat and Amber Durum Wheat. Grade and protein segregations were used for Hard Red Spring Wheat to increase the number of segregations handled in the analysis to seven.

The limiting factor in terminal operations throughout the analysis was the capacity of the wheat/barley cleaners in the terminal. The Alberta Wheat Pool terminal has five sections of wheat/barley cleaners, one of which is dedicated to cleaning barley which accounted for 17 percent of terminal shipments during crop years 1981/82 and 1982/83. The other four sections of wheat/barley cleaners cleaned the 12 segregations of wheat which accounted for 72 percent of the terminal's throughput during these two crop years.

The analysis indicates that as the number of grains and/or grades handled increased, throughput decreased at a decreasing rate. Although the analysis was not carried out beyond seven segregations it is likely that as segregations increase, eventuallly a point may be reached where the addition of one more grade would not result a signficant decrease in throughput.

The analysis is limited by the particular assumptions concerning sufficient grain supply in the teminal and no limitations on out-loading to ships, which are assumed to be readily available as needed. The extent for which the latter assumption in particular, reflects terminal operations, may vary over time. The study may also be constrained by the available data which relates to one terminal only. Nevertheless, the table indicates that increasing the number of grades handled by a terminal decreases the throughput. The throughput was reduced from 8,750,000 tonnes to 5,500,000 tonnes when the number of grains and/or grades increased from one to seven.[198] It also suggests the cleaning function, the need to allocate cleaners to various grains, and the need to change cleaner screens to accomodate different grains, represent significant impediments to maintaining terminal elevator throughput.

E. Summary

This Chapter described the data requirements, problems encountered in data collection and an analysis of the available data concerning this study. Due to data limitations, the analysis of the effects of the Canadian grain grading system on the operations of the Vancouver terminals was restricted primarily to one terminal, Alberta Wheat Pool. However, this analysis may provide some insight into the overall situation. A summary of the analysis carried out in this Chapter appears in Table VI-2 following.

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[198] The calculations and assumptions used to determine the throughput for the different scenarios are presented in Appendix 1.

TABLE VI-1 THE ESTIMATED EFFECT OF HANDLING ADDITIONAL GRAINS OR GRADES ON A VANCOUVER TERMINAL'S THROUGHPUT, 1985

	Scenario		Probability of the Arrival of Single Car Lots	Estimated Unloads Per Shift	Maximum Cleaning Capacity per Shift	Amount Directed to the Annexes per Shift	Extra Hours of Cleaning Required per Week	Estimated Potential Annual Throughput
	Grains	Grades		(tonnes)	(tonnes)	(tonnes)	(hours)	(tonnes)
1.	1	0	0	11,218	10,850	395	2.75	8,750,000
2.	2	0	.32	10,270	10,850	0	0	8,011,000
3.	3	0	.44	8,374	5,425	1,975	38.25	6,532,000
4.	3	1	.62	7,900	5,425	1,617	31.5	6,162,000
5.	3	2	.74	7,821	5,197	1,757	35.5	6,100,000
6.	3	3	.81	7,426	4,725	1,884	42	5,792,000
7.	3	4	.82	7,047	4,480	1,792	42	5,497,000

TABLE VI-2: ANALYSIS OF OPERATION SCENARIOS; ALBERTA WHEAT POOL TERMINAL, 1985

I. RECEIVING OPERATIONS

Situation	Unloads Per Shift		Unloads Per Day (3 shifts)		Unloads Per Year (260 working days)
	Cars	Tonnes	Cars	Tonnes	Tonnes
A. PRESENT					
i) Estimate Average	70-75	5,530-5,925	210-225	16,590-17,775	4,313,400-4,621,500
ii) Rated Capacity	90	7,110	270	21,330	5,545,800
Difference	15-20	1,185-1,580	45-60	3,555-4,740	924,300-1,232,400
B. PRE-GRADING OPTION					
i) Method 1 (Increase of 27.5% over present)	89-95	7,031-7,505	267-285	21,093-22,515	5,484,180-5,853,900
Estimated Increase	19-20	1,501-1,580	57-60	4,503-4,4740	1,170,780-1,232,400
ii) Method 2 (Potential)	114	9,006	342	27,019	7,024,680
Estimated Increase	39-44	3,081-3,476	117-132	9,243-10,428	2,403,180-2,711,280
C. TRACK WEIGHING (GRAIN GRADED AT THE TERMINALS) OPTION					
i) Increase Present Average	76-81	6,004-6,399	228-243	18,012-19,197	4,683,120-4,991,220
Estimated Increase	6	474	18	1,422	369,720
ii) Potential	98	7,742	294	23,226	6,038,760
Estimated Increase	23-28	1,817-2212	69-84	5,451-6636	1,417,260-1,725,360
D. TRACK WEIGHING/PRE-GRADING - COMBINED OPTIONS					
Potential	150	11,850	450	35,550	9,243,000
Estimated Increase	75-80	5,925-6,320	225-240	17,775-18,960	4,621,500-4,929,600
E. HYPOTHETICAL MAXIMUM RECEIVING POTENTIAL[1]					
Potential	252	19,908	756	59,724	15,528,240

....continued

TABLE VI-2: (CONTINUED)

II. CLEANING OPERATIONS (WHEAT/BARLEY SYSTEMS)

Situation	Tonnes Per Hour	Tonnes Per Shift (7 hrs.)
A. PRESENT		
i) Measured Rate (including 12 min/car set-up time	128	896
ii) Reduction Due to Minimum 54.1 percent requiring two passes	44.8	313.6
iii) Reduction Due to Recycling (10 percent/car)	12.6	88.2
iv) Estimated Present Clean Rate (each section)	70.6	494.2
v) Estimated Terminal Cleaning Capacity (5 sections)	353	2,471
B. PREGRADING (REDUCED SET-UP TO 6 MINUTES) OPTION		
i) Estimated Capacity (each section)	81.3	569.1
ii) Estimated Terminal Capacity (5 sections)	406.5	2,845.5
C. REDUCTION OF TOLERANCES (ONE PASS CLEANING) OPTION (6 MINUTE SET-UP TIME)		
i) Estimated Capacity (each section)	148.48	1,039.36
ii) Estimated Terminal Capacity (5 sections)	742.4	5,196.8
iii) Estimated Terminal Capacity Increase	389.4	2,725.8
D. HYPOTHETICAL MAXIMUM CLEANING POTENTIAL[2]		
Per Section	155	1,085
Per Terminal	775	5,425

....continued

TABLE VI-2: (CONTINUED)

III. STORAGE

			Tonnes
A. ACTUAL			
1) A.W.P.	(a) Elevator		282,830
	(b) Annex		256,259
2) Vancouver Total			929,290
B. TURNOVER			
1) A.W.P.	(a) Average, 10.5 times per year		2,969,715
	(b) High, 12.2 times per year		3,450,526
	(c) Difference		480,811
2) Vancouver	(a) Average, 10.7 times per year		9,943,403
	(b) High, 12.2 times per year		11,337,338
	(c) Difference		1,393,395
C. ACHIEVE CHURCHILL'S TURNOVER (19.2 TIMES PER YEAR			
1) Vancouver			17,842,368
2) A.W.P.			5,430,336
D. REQUIREMENT TO ACHIEVE CHURCHILL RATE			
1) Unload per Day (260 days)		(264 cars)	20,886
2) Hours Cleaning per Day	(742.4 tonnes/hour) = 28.13		
	(775 tonnes/hour) = 26.95		

[1]Assumes: 1) Only one grade of grain received;
2) Car cycle time reduced to 5 minutes due to distribution system changes required by filled bins.

[2]Assumes that set-up time can be reduced to 3 minutes per car.

Source: Swan Wooster Engineering Limited, *Alberta Wheat Pool Vancouver Terminal Simulation Analysis*, February 1984.
Canadian Transport Commission, Untitled, 1981 (Mimeograph).
Canadian Grain Commission, *Grain Elevators in Canada: Crop Year 1984/85*.
Personal Communication with John Marchiori (February 1985); and David Ball (May 1985).

VII. Summary, Conclusions and Recommendations

The objectives of this study were: 1) to determine and describe the effects of the Canadian grain grading system on the operational efficiency of Vancouver terminal elevators, 2) to quantify the additional cost of terminal operations attributable to the current grain grading system, and 3) to analyze the effect of additional grades on the throughput of terminal elevators. A lack of cost data concerning specific operations inhibited full realization of the second objective; thus, a complete analysis of terminal costs attributable to the grading system was not accomplished. However, through personnal communication, use of time and motion study information, weighover information, and shipping records, proxies were utilized to derive estimates of the effects of the grading system on the operational efficiency of the Vancouver terminals.

Throughout the analysis, terminal elevator throughput was used as a measure of cost. It was assumed that throughput provided the best measure of operational efficiency, as throughput is the dependent factor of terminal elevator input/output relationships.

Increasing terminal elevator throughput is important for two reasons: 1) to ensure Canada can meet export demand in the future, and 2) to reduce the average cost per tonne of grain handled, assuming capital and fixed costs remain the same. A reduction in the average cost per tonne of grain could either increase Canada's competitive edge in world grain trade by lowering the price, or be passed backwards to the producer, increasing producer net country point prices. Producers total returns could increase through either higher net producer prices or increased grain sale reducing grain stored on-farm between crop years.

A. Summary

The grain grading system in Canada has evolved over the past century. During this period, changes to the system were made in response to conditions prevalent at the time. However, once implemented, these changes appear to persist in the system, perhaps due to tradition and or a lack of economic evidence proving that in some cases costs are greater than benefits. The scope of this thesis was limited to the costs attributable to the grading system; therefore, the benefits were not discussed.

Three general facets of the grading system discussed in the thesis were: 1) grading at the terminals, 2) primary versus export standards and differences in tolerances for foreign material, and 3) the multiplicity of grades in the grading system.

Grading at the Terminals

Officially grading grain at the terminals appears to have the greatest influence on receiving operations. Pre-graded grain arriving at the terminals could increase unloads per shift and elevator throughput. Advantages of pre-grading grain were determined as follows;

1. Pre-grading would eliminate the time spent waiting for official grading of the grain, thus increasing unloading efficiency.
2. The terminal operator could better coordinate activities based on knowledge of what grains were arriving. This could reduce the time spent setting the distribution system.
3. Advanced notice of grades arriving could allow for more efficient use of storage space.
4. Pre-grading would facilitate use of track weighing. Together these measures could increase unloads as much as 100 percent per shift over the present rate.
5. Pre-grading could facilitate the assemblage of cars into large lots on the Prairies. This would allow delivery of grain cars containing the same grade to terminals reducing the number of times the distribution system needed to be set, thus increasing unloads.
6. Pre-grading would allow terminal operators to reject misshipped or off-grade grains. In addition, pre-grading might prevent carloads of rejected or condemned grains from leaving the Prairies, thus saving on transportation and storage costs.

Primary and Export Standards

The existence of both primary and export standards and differences in foreign material tolerance levels between the two standards results in a cost to the terminals. Reducing the differences between primary and export standards and increasing the maximum tolerance levels for foreign material could reduce the average cost per tonne of grain handled. Costs could be reduced by:

1. Decreasing the amount of grain which needs to be cleaned more than once.
2. Reducing the amount of overtime required to clean and reclean grain.
3. Allowing the terminal more leeway in blending export grain.
4. Reducing the risk of a terminal having to unload ships due to grain not meeting the current export standards (especially in light of the fact that some terminals have difficulty in obtaining enough high quality grain in a grade to bring grain up to the export standards).

The Multiplicity of Grades in the Grading System

The multiplicity of grades in the system is perceived to provide benefits by enabling Canada to meet customers' specific requirements. However, this multiplicity of grades exerts a cost in terms of elevator throughput. A reduction in the number of grades could improve elevator efficiency and reduce costs through:

1. Reducing grading time, as fewer grading factors might be required.
2. Increasing the amount of usable storage space as fewer segregations could mean fewer partially filled bins.
3. Increasing the turnover of storage space as fewer segregations would facilitate the buildup of shipment size parcels of grain.

Conclusions

Due to data limitations, this study is unable to conclusively state the actual costs incurred by the terminal elevator operators due to the present Canadian grain grading system. However, within the data limitations and the assumptions used, the study indicates that the Canadian grain grading system has a negative effect on terminal elevator throughput.

Terminal elevators have a dual role within the Canadian grain handling system. On one hand they are public houses in that they provide services to the Canadian Wheat Board and exporters who lack facilities. On the other hand the terminals are marketers for grains and grain byproducts owned by the terminal elevator company. This duality in roles may lead to a conflict of interest on the part of the terminal operator as there is a responsibility to both their customers and their company. For example, screenings from cleaning and other byproducts are the property of the teminal and as such may provide revenues above the value of the services rendered. The presence of an easily accessed market with an attractive market price for byproducts may provide an incentive to overcleaning grain at the teminals. Although the low tolerances for dockage in export grain contribute to the burden placed on the teminals, the role of the teminal as a marketer may also contribute to this problem.

The present number of segregations for wheat appears to be the dominant factor in reducing terminal throughput. Although wheat constituted 72 percent of the grains shipped curing crop years 1981/82 and 1982/83, they also constituted 12 of the 23 segregations handled. Due to the necessity of cleaning grains other than wheat, the terminal is unable to dedicate all available workhouse space to wheat barley cleaners. The space limitation coupled with the number of segregations maintained for wheats, especially the Hard Red Spring Wheats, appears to be the factor which reduces the ability of the teminals to increase throughput. A reduction in the number of grades and/or protein segregations maintained for the Hard Red Spring Wheats, could likely increase terminal throughput.

A reduction in the number of grades or changes in the grading system to increase teminal throughput may not be viable due to delays in vessel arrivals which cause elevator plugging. Potential increases will only be acheivable if vessel arrivals are scheduled to ensure that there is a continuous flow of grain through the terminal.

It is possible that some changes could be made to the grading system which could increase terminal elevator throughput. However, theses changes could jeopardize Canada's reputation as an exporter of high quality grains. Therefore, it is possible that the benefits accrued to the Prairie grain producer by the present grain grading system outweigh the costs outlined in this thesis. Prior to any real judgements being made, more research is required into both the costs and the benefits of the present grain grading system.

B. RECOMMENDATIONS

The terminal operator is restricted in the amounts which may be charged for services rendered by the maximum tariffs set by the Canadian Grain Commission. The terminal elevator customer is charged a specified rate for services rendered by the terminal which may be below or at the maximum tariff rate. None of the participants in the grain industry are sure of the actual cost of each terminal operation.

The tariff system currently appears to work as the terminals remain in operation; but they do not earn large profits. As no cost data for individual operations exist, the tariffs are set at or near the maximum levels by the terminals as a safeguard. Customers may be paying either too much or too little for each service. As the terminals do not charge variable rates based on the quality of the grain received, there is a lack of incentive for terminal customers to ensure that the grain shipped to the terminals requires little conditioning.

It is the contention of this author that the tariff system should be changed to require terminal operators to prove costs of individual operations prior to tariffs being set. Although this measure may initiallybe costly, in the long run the information provided will permit a thorough analysis of the Canadian grain grading system on an economic basis and permit future changes.

C. NEEDS FOR FURTHER RESEARCH

This study and a previous study[199] investigated the effects of the Canadian grain grading system on the grain handling system in Canada. The benefits accrued to Prairie producers by the grading system were not measured in either study. Prior to changes being made to the grading system, the benefits should be determined.

Certain facets, such as protein segregation, were implemented due to competitors using this method of segregation. However, these segregations add costs to the handling and transportation system. Prior to the addition of grades to the system, the benefits of present grades should be analyzed to determine if any reduction in grades could be made.

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[199] W.J.Hoar, M.H.Hawkins, and M.L.Lerohl, "The Effects of Domestic Grain Grades on the Operational Efficiency of Alberta Primary Elevators", *Agriculture and Forestry Bulletin* Vol.6, No.4,(Edmonton:The University of Alberta, 1983) pp.53-56.

The present method of determining grades at the terminal elevators was shown in this study to reduce unloading capacity of terminals. Methods of grading inland should be investigated as a possible alternative. One alternative which could be analyzed is use of automatic samplers at primary elevators during the rail car loading operation. The samples could be sent via the daily courier system to a central location, such as Edmonton or Calgary, for analysis. The grades would be determined prior to the rail cars arriving at the rail yards in Edmonton or Calgary, and trains could be assembled on this basis. Alternately, if grading could not be accomplished rapidly enough for the assembly of a train, the information could be fowarded by electronic means to Vancouver. Research into this and other alternative methods of grading prior to arrival at the terminals may provide a way to increase the throughput of the Vancouver terminal elevators.

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APPENDIX 1

The numbers which appear on Table VI-1 are rounded-off, as the calculations below are based on assumptions and therefore are not as accurate as they appear.

SCENARIO 1

The terminal was assumed to receive one grain. The determination of throughput in this situation required two further assumptions.

1. The entire workhouse space would be allocated to wheat/barley type cleaners, resulting in 10 cleaning sections rather than the 5 which are available at present.[200] These cleaners would clean at the hypothetical maximum rate calculated in Chapter VI (see Table VI-1), resulting in an estimated cleaning capacity of 10,850 tonnes per shift.
2. The car cycle time was assumed to be the 8.7 minutes calculated under the pre-grading assumption in Chapter VI. When the total amount of grain which could be cleaned per shift had been received(10,850 tonnes), the remaining grain would be allocated to the annex to await cleaning. This would increase the car cycle time to the 14.4 minutes per carload for grain distributed to the annex estimated in Chapter VI in the pre-grading scenario.

The resulting throughput was calculated as follows:

- Unloads required to reach cleaning capacity, (10,850 tonnes)/79 tonnes per car=approximately 137 cars
- Time required to unload 137 cars: 137cars x 8.7 minutes per car = 1191.9 minutes.
- Total minutes available each shift: 7 hours x 60 minutes per hour x 3 receiving systems = 1260 minutes.
- Unloads to Annexes: (1260 minutes - 1191.9 minutes)/14.4 minutes per car =approximately 5 cars.
- Total possible unloads per shift: (137 cars + 5 cars) x 79 tonnes per car =11,218 tonnes per shift.
- Total possible unloads per year (based on 3 shifts per day for 260 days per year): 11,218 tonnes per shift x 3 shifts per day x 260 days per year =8,750,040 tonnes per year.
- Overtime hours required on weekends to clean grain: ((5 cars per shift x79 tonnes per car)/10,850 tonnes/shift)x 3 shifts per day x 5 days per wekk =.55 hours per week for each cleaning section or 5.5 hours for one section.

SCENARIO 2

The terminal receives two grains, wheat and barley, in proportions of 80 percent wheat and 20 percent barley.[201] The assumption of cleaning capacity in Scenario 1 is maintianed as the cleaning sections can be allocated on the basis of 8 for wheat and 2 for barley. However, the car cycle time is increase due to the changing of the distribution system as now two grains are received. Based on the Swan-Wooster study, the average time to set the mayo was 3 minutes for grain distributed to the workhouse. Assuming that the grain cars are randomly distributed, there is a .32 probability of receiving single car lots.[202] Multiplying the average time to set the mayo by the probability of single car lots increases the car cycle time by .96 minutes to 9.66 minutes per car. Potential throughput was calculated as follows:

- Unloads per shift: 1260 minutes per shift/9.66 minutes per car =130 cars per shift.

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[200]The cleaners used at A.W.P. for wheat and barley are interchangable. There are 5 cleaning sections which contain several machines operating in parallel. In addition there are 40 other cleaners. Assuming that the terminal receivies grain which is cleaned by the wheat and barley type cleaners only, the space allocated for the other cleaners could be used for wheat and barley cleaners. Thus it was assumed that this space could be used for 5 additional wheat/barley cleaners.

[201]This is approximately the ratio of total wheat and total barley shippments from the A.W.P. terminal during crop years 1981/82 and 1982/83.

[202]Probabilities were calculated using the Product Rule. In this case, .8 x .2 +.2 x.8 =.32.

As this is lower than the 137 cars per shift cleaning capacity no car loads were directed to the annexes.

- Estimated Total Annual Throughput: 130 cars per shift x 3 shifts per dayx 260 days per year x 79 tonnes per car = 8,010,600 tonnes.

SCENARIO 3

The terminal receives 3 grains, wheat, barley and other grains, with 72, 17, and 11 percent distribution, respectively.[203] The cleaning capacity fro wheat and barley was reduced by 50 percent as it was assumed that the terminal reverted to it's present configuration of only 5 sections of wheat and barley cleaners and cleaner for other grains. In addition, it was assumed that due to the small amount of other grain received, the cleaning capacity was not a bottle neck for this 'other grain'.

The cars were assumed to arrive randomly, resulting an a .44 probability of single car lots arriving. Adjusting for setting of the distribution system, car cycle times were calculated to be 10.02 minutes for grain distributed to the workhouse[204] and 17.48 minutes for grain distributed to the annexes.[205] It was assumed that the cleaning sections were allocated barley and wheat on a 1:4 basis. The total cleaning capacity for both wheat and barley, therefore, was estimated at 5425 tonnes per shift. Once unloads had reached the wheat and barley cleaning capacity, additional unloads were directed to the annexes. Throughput was calculated as follows:

- Unloads to reach wheat/barley cleaning capacity: 5425 tonnes per shift/(.79 tonnes per car x .89 wheat and barley of total grain)=77 cars per shift.
- Time required to reach cleaning capacity: 77 cars x 10.02 minutes per car = 771.54 minutes.
- Remaining time to direct wheat and barley to annexes: 1260 minutes per shift - 771.54 minutes =448.46 minutes per shift.
- Average car cylcle time for remainder of the shift (all grain):(.11 percent other grains x 10.02 minutes per car) + (.89 percent wheat and barley x 17.48 minutes per car) = 16.66 minutes per car.
- Additional unloads during remainder of the shift:488.46 minutes / 16.66 minutes per car =29 cars.
- Amount of wheat and barley per shift requiring overtime cleaning: 29 cars x .89 wheat and barley cars x 79 tonnes per car =1975 tonnes per shift.
- Overtime hours required to clean wheat and barley:(1975 tonnes per shift/ 5425 tonnes per shift) x 7 hours per shift =2.55 hours per shift.
- Estimated unloads per shift; (77 cars +29 cars) x 79 tonnes per car = 8374 tonnes per shift.
- Estimated Annual Throughput: 8374 tonnes per shift x 3 shifts per day x 260 days per year = 6,521,620 tonnes.

SCENARIO 4

The terminal receives 4 grains or grades, hard wheat, other wheat, barley and other grains in the following distribution 56, 16, 17 and 11 percent respctively.[206] Although the probability of receiving single car lots is .62, if the cars are randomly distributed, using this increases the car cycle times beyond the averages calculated by Swan-Wooster. The reason being that when cars are picked up on the Prairies on train runs grains and grades along the train run tend to be similar. The result is that cars are not actually randomly distributed when they reach Vancouver. Due to these factors the

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[203]These ratios correspond to the raito of total wheat, total barley and total other grains which were shipped by the A.W.P. terminal during crop years 1981/82 and 1982/38.

[204]Calculated as follows: (.44 x3 minutes) + 8.7 minutes =10.02 minutes.

[205]Calculated as follows: (.44 x 7 minutes) + 14.4 minutes = 17.48 minutes.

[206]The scenario grades correspond as follows; hard wheat consists of all grades of hard red spring wheat and Canada Feed wheat; other wheat is made up of Amber Durum Wheat, Red Winter Wheat and Special Bin Wheat, barley includes all barley and other grains includes everything elese. The ratios used are based on the A.W.P. terminal shipments of these grains during the 1981/82 and 1982/83 crop years

maximum car cycle times will be maintained at the Swan-Wooster averages of 11.2 minutes for grain directed to the workhouse and 18.2 minutes for grain directed to the annex. In addition, it is assumed that the wheat/barley cleaners are allocated on the basis of 3 for hard wheat and 1 each for other wheat and barley. The cleaning capacity is maintained at 5425 tonnes per shift. Throughput is calculated as follows:

- Cars required to reach wheat/barley cleaning capacity: 77 (see Scenario 3)
- Time required to reach wheat/barley cleaing capacity: 77 cars x 11.2 minutes per car = 862.4 minutes
- Time remaining in shift: 1260 minutes per shift - 862.4 minutes =397.6 minutes.
- Average car cycle time for remained of shift: (.11 x 11.2 minutes) +(.89 x 18.2 minutes) = 17.43 minutes.
- Cars unloaded during remainder of the shift: 397.6 minutes / 17.43 minutes per car = 23 cars.
- Hard wheat, other wheat and barley requiring overtime cleaning: (.89 x 23 cars) = 1617 tonnes per shift. Estimated overtime hours required per week to clean hard wheat, other wheat and barley: (1617 tonnes / 5425 tonnes) x 15 shifts per week x 7 hours per shift = 31.5 hours per week.
- Estimated unloads per shift: (77 cars + 23 cars) x 79 tonnes per car =7900 tonnes per shift.
- Estimated annual throughput: 7900 tonnes per shift x 3 shifts per day x 260 days per year =6,162,000 tonnes per year.

SCENARIO 5

The terminal receives 5 grains or grades, No.1 hard wheat, No. 2 hard wheat, other wheat, barley and 'other grains' with a 42,14,16,17, and 11 percent distribution respectively.[207] The car cycle times are assumed to remain the sames as in Scenario 4. However, due to an additional segregation, the setup time for the wheat/barley cleaners is assumed to increase to 6 minutes from the 3 minutes used to achieve the 5425 tonnes per shift capacity. The increase in setup time reduces the cleaning capacity for these cleaners to 5196.8 tonnes per shift (see Table VI-1). The other assumptions indicated in Scenario 4 remain the same. Throughput is calculated as follows:

- Cars required to reach wheat/barley cleaning capacity: 5196.8 tonnes/(79 tonnes per car x .89) =74 cars of all grains.
- Time required to reach wheat/barley cleaning capacity: 74 cars x 11.2 minutes per car = 828.8 minutes.
- Time remaining in shift: 1260 minutes per shift - 828.2 minutes = 431.2 minutes in shift.
- Unloads during remainder of shift: 828.8 minutes/17.43 minutes per average car cycle = 25 cars.
- Estimated wheats and barley requiring overtime cleaning per shift: 25 cars x .89 x 79 tonnes per car = 1757.75 tonnes
- Estimated weekly overtime hours required to clean wheats and barley: (1757.75 tonnes per shift / 5196.8 tonnes per shift x 15 shifts per week x 7 hours per shift = 35.5 hours per week.
- estimated unloads of all grains per shift = (74 cars + 25 cars) x 79 tonnes per car = 7821 tonnes per shift.
- Estimated annual throughput: 7821 tonnes per shift x 3 shifts per day x 260 days per year = 6,100,380 tonnes per year.

SCENARIO 6

The terminal receives 6 grains or grades, No.1 hard 13.5 wheat, No.1 hard 12.5 wheat, No.2 hard wheat, other wheat, barley, and 'other grains', distributed as follows, 30, 12, 14,16, 17, and 11 percent, respectively.[208] Due to the addition of another grade,

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[207] No.1 hard wheat corresponds to No.1 C.W.R.S and No. 2 hard wheat corresponds to No.s 2 and 3 C.W.R.S. and Canada Feed Wheat. The other grains in the Scenario remain as in Scenario 4.

[208] No.1 hard 13.5 wheat corresponds to No.1 C.W.R.S. 13.5 and 14.5, and No.1 hard 12.5 wheat corresponds to No.1 C.W.R.S. 12.5, other grades remain the same as in Scenario 5.

- it was assumed that an additional 3 minutes for the wheat/barley cleaner setup time was required per car. Cleaning capacity for each section was, therefore, reduced to 135 tonnes per hour per section resulting in a total cleaning capacity per shift of 4725 tonnes. The total number of shifts per week, including weekends, available for cleaning is 21. The weekly cleaning capacity was found to be the limiting factor in this scenario. Throughput was calculated as follows:

- Estimated maximum cleaning capacity for wheat/barley cleaner: 21 shifts per week x 4725 tonnes per shift =99,225 tonnes per week.
- Estimated allowable amount of unloads per receiving shift (wheats and barley): 99,225 tonnes per week / 15 shifts per week / 79 tonnes per car = 84 cars.
- Estimated total unloads per receiving shifts of all grains: 84 cars of wheat and barley / .89 wheat barley ratio x 79 tonnes per car = 7426 tonnes per shift.
- Estimated Annual Throughput:7426 tonnes per shift x 3 shifts per day x 260 days per year = 5,792,280 onttes per year.

SCENARIO 7

The terminal receives 7 grains or grades with the following distribution, No.1 hard 13.5 wheat, 30 percent; No.1 hard 12.5 wheat, 12 percent; No.2 hard wheat, 14 percent; red winter wheat, 7 percent; amber durum wheat, 9 percent; barley, 17 percent; and 'other grains' 11 percent.[209] In this scenario, the addition of another segregation for the wheat /barley cleaners is assumed to increase the cleaner setup time to 12 minutes per car, reducing the cleaning capacity to 128 tonnes per hour per section. This is the rate which was measured by A.W.P. for actual conditions at the terminal. The total cleaning capacity for these cleaners per shift is, therefore, 4480 tonnes per shift. The total number of hours available per week for cleaning is assumed to be the limiting factor to throughput in this scenario. Throughput is calculated as follows: Estimated total weekly cleaning capacity:

- 4480 tonnes per shift x 21 shifts per week = 94,080 tonnes per week.
- Estimated allowable amount of wheat and barley unloads per receiving shift: 94080 tonnes per week / 15 shifts per week = 6272 tonnes per shift.
- Estimated tonnes of all grains unloaded per receiving shift: 6272 tonnes per shift wheat and barley / .89 wheat and barley ratio = 7047 tonnes per shift of all grains.
- Estimated annual throughput: 7047 tonnes per shift x 3 shifts per day x 269 dats per year = 5,496,660 tonnes per year.

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[209] The previous grade 'other wheat' has been broken down to two grades, amber durum which corresponds to all grades of amber durum and special bin wheat shiped and red winter wheat which corresponds to all grades of red winter wheat shipped by A.W.P. during crop year 1981/82 and 1982/83.