

Shovel Operator

Occupational Analysis Report

November 2011



Commission
de la construction
du Québec

The purpose of this report is to describe as accurately as possible the shovel operator trade as currently practiced in Québec's construction industry. It is a record of discussions held by a group of workers who met for the occasion after industry partners recommended them to the Commission de la construction du Québec for their expertise in the trade.

The occupational analysis is a first step in the definition of the competencies required for practicing the trade. This report becomes one of the reference and decision-making tools used by the Commission for teaching and learning purposes.

The present report does not bind the Commission in any way. It has no legal effect and is meant as a reflection of discussions held on the date of the analysis workshop.

PRODUCTION TEAM

The Commission de la construction du Québec wishes to thank the production team for this occupational analysis.

Responsibility

Jean Mathieu

Section Manager

Commission de la construction du Québec

Coordination

Doris Gagnon

Training Advisor

Commission de la construction du Québec

Conduct of the workshop and writing of the report's validated version

Jean-François Pouliot

Training Consultant

Note-taking

Michel Caouette

Training Consultant

Production support

Roger Voghel

Shovel Operator, Content Expert

Michel Couillard

Training Advisor

Commission de la construction du Québec

Secretariat and page layout

Sylvie Brien

Commission de la construction du Québec

Translation

Traductions Globe Translations inc.

The masculine gender is used generically
in this document to facilitate reading.

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Josée April
Shovel Operator
Entreprise Vaillant
Montréal

Sebastien Bélisle
Shovel Operator
Demix construction
Laval

Réjean Bernard
Shovel Operator
EBC
Québec

Jasmin Bouthillier
Shovel Operator
Entreprise CR Ménard
Longueuil

Alain Gauthier
Shovel Operator
Jean-Claude Alary excavation
Terrebonne

Charles Hayeur
Shovel Operator
Doncar construction
Laval

Alain Jasmin
Shovel Operator
Action Démolition HL
Longueuil

Michel Léveillé
Shovel Operator
IRS, Bauval
St-Hyacinthe

Gilles Mayer
Shovel Operator
Équipement d'excavation Quatre Saisons
St-Jérôme

Pierre Plante
Shovel Operator
Roxboro excavation
Dorval

Patrick Witty
Shovel Operator
IRS, Bauval
St-Hyacinthe

The following persons attended the meeting as observers:

Michel Couillard

Training Advisor

Commission de la construction du Québec

Marie Talbot

Sector Manager

Ministère de l'Éducation, du Loisir et du Sport

Laila Valin

Evaluation Advisor

Commission de la construction du Québec

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APPROVAL

This occupational analysis report was read and approved by Commission de la construction du Québec authorities and the following persons on the dates mentioned below:

Shovel Operator Professional Subcommittee

February 27, 2012

Pierre Maisonneuve

Association de la construction du Québec

Thomas Ducharme-Dupuis

Vincent Gagné

Association des constructeurs de routes et grands travaux du Québec

Guy Giasson

Association provinciale des constructeurs d'habitations du Québec

Alain Pépin

Centrale des syndicats démocratiques – Construction

Pierre Brassard

Confédération des syndicats nationaux – Construction

Dominic Girard

Fédération des travailleurs et travailleuses du Québec – Construction

Alain Bousquet

Syndicat québécois de la construction

Committee on Vocational Training in the Construction Industry

March 15, 2012

Board of Directors

April 26, 2012

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INTRODUCTION

In early 2009, the CCQ's Direction de la formation professionnelle launched a large-scale operation to review the occupational analyses¹ of all construction industry trades.

The CCQ undertook this operation for many reasons, particularly the following:

- the project to reform the construction workforce apprenticeship and management system, and the eventual design of qualitative apprenticeship booklets requiring a detailed description of each trade;
- the fact that most construction occupational analyses² had been conducted between 1987 and 1991 and had not been reviewed since;
- updates to vocational qualification examination question banks;
- implementation of Chapter 7 of the Agreement on Internal Trade (AIT) and of the Québec-France Understanding on the Mutual Recognition of Professional Qualifications.

These factors demonstrate the necessity of updating the occupational analyses in order to obtain a current and complete profile of the various trades in Quebec.

The occupational analysis of the shovel operator trade belongs to this context³. Its purpose is to describe this trade as currently practiced by journeymen in the construction industry. The present report was written in order to collate and organize the information gathered during the occupational analysis workshop held in Laval on March 17 and 18, 2011.

This analysis aims to draw a portrait of the trade (tasks and operations) and its working conditions, and to identify the skills and behaviours required. The report of the occupational analysis workshop is an accurate reflection of the consensus reached by a group of experienced shovel operators. A special effort was made to include in this report all the data collected during the workshop and to ensure that the data accurately depict the realities of the trade analysed.

1. The terms "profession" and "trade" are considered synonymous.

2. Called "work situation analyses" at the time.

3. This occupational analysis was conducted according to the *Cadre de référence et instrumentation pour l'analyse d'une profession* produced in 2007 by the ministère de l'Éducation, du Loisir et du Sport (Direction générale de la formation professionnelle et technique) and the Commission des partenaires du marché du travail, ministère de l'Emploi et de la Solidarité sociale.

1. GENERAL CHARACTERISTICS OF THE TRADE

1.1 DEFINITION OF THE TRADE

According to the Regulation respecting the vocational training of workforce in the construction industry (Schedule A, section 4), the term “shovel operator” means:

[...] Anyone who operates all types of shovels, backhoes, cranes with clamshell or dragline attachments, pivoted arm excavators and any other stationary or mobile excavating equipment, track-mounted or on wheels.

A shovel operator also operates the above equipment when it is electrically-driven.

According to several of the participants, it is established on construction sites that backhoes are operated by heavy machinery operators.

Some of the participants mentioned a grey area between the trades of crane operator and shovel operator with regard to cranes equipped with clamshell or dragline attachments. It was pointed out that many such shovels used to operate with cables. But nowadays, as is the case for the great majority of shovels in service, they operate hydraulically.

The participants also have doubts about pivoted arm excavators. The latter are unknown to several of the persons who were in attendance. Some of the participants think this type of excavator is used in mines as a remote-controlled shovel.

1.2 JOB TITLES

The job title used for describing the practice of the trade in the present occupational analysis is “shovel operator.”

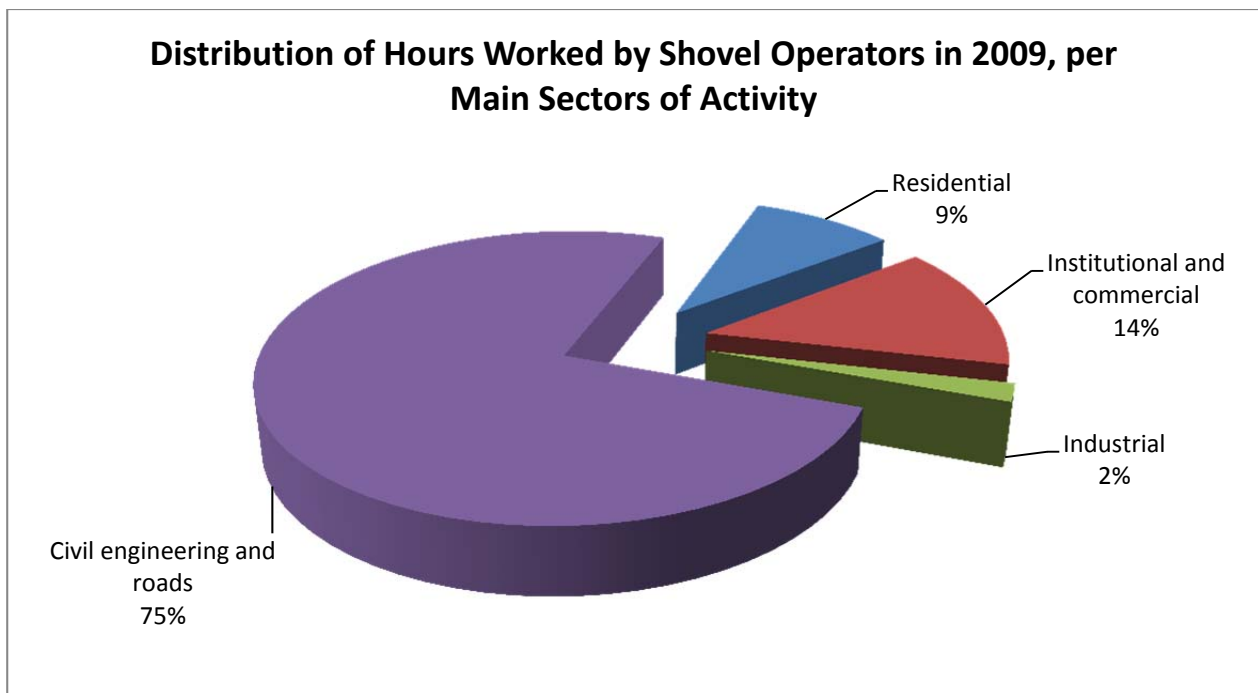
According to the participants, the job title not to be confused with that of shovel operator is “heavy machinery operator.”

Finally, it should be mentioned that the profession includes classes defined according to the shovel's loading capacity:

- Class AA: 6 cubic yards or over;
- Class A: 1 to 6 cubic yards;
- Class B: less than 1 cubic yard.

1.3 SECTORS OF ACTIVITY

Shovel operators are active, to various degrees, in the four construction industry sectors. The following is the workload for this trade⁴:



The shovel operators attending the workshop consider that the above table corresponds well to their perception of the sites where they practice their trade.

Questioned on the sector of activity where they work, the participants stated that they work mainly in the civil engineering and roads sector.

4. Commission de la construction du Québec, *Carrières construction*, 2010-2011 edition.

Six of the participants work in another sector. Thus, two of them reported having also worked in the industrial sector; two others in the institutional and commercial sector; and two others in the residential sector.

The participants added that excavation work is very similar from one sector to another.

1.4 FIELD OF PRACTICE

The trade's field of practice is the construction industry. The Act respecting labour relations, vocational training, and workforce management in the construction industry (R.S.Q., c. R-20) defines construction as follows:

[...] the foundation, erection, maintenance, renewal, repair, alteration and demolition work on buildings and civil engineering works carried out on the job site itself and vicinity including the previous preparatory work on the ground;

In addition, the word "construction" includes the installation, repair and maintenance of machinery and equipment, work carried out in part on the job site itself and in part in the shop, moving of buildings, transportation of employees, dredging, turfing, cutting and pruning of trees and shrubs and laying out of golf courses, but solely in the cases determined by regulation.

1.5 LEGISLATION, REGULATIONS AND STANDARDS

Shovel operators in the construction industry are subject to:

- the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20);
- the Regulation respecting the vocational training of workforce in the construction industry (R-20, r.6.2);
- the four sector-based collective agreements of the construction industry;
- the National Building Code – Canada (NBC);
- the Act Respecting Occupational Health and Safety (R.S.Q., c. S-2.1);

- the Safety Code for the construction industry (R.Q. c. S-2.1, r.6);
- municipal bylaws, particularly regarding working hours and nuisances (construction site schedules, noise and dust);
- environmental regulations regarding, for example, sedimentation barriers, soil decontamination, wetland protection, etc.

1.6 WORKING CONDITIONS⁵

The following information provides an overview of the conditions and context of the work of shovel operators, as commented by the participants in the occupational analysis workshop. To obtain up-to-date and complete information that has legal effect, it is necessary to refer to the four collective agreements of the construction industry sectors.

Salary

The average annual salary of a shovel operator in the construction industry was \$38,304 in 2009.

The *hourly* wage varies slightly by sector of activity and job classification. In March 2011, a journeyman's daytime hourly wage was as follows:

Job Classification	Industrial, Institutional and Commercial	Civil Engineering and Roads	Light Residential	Heavy Residential
Class AA	\$33.79	\$33.23	—	—
Class A	\$32.74	\$32.28	\$29.73	\$32.76
Class B	\$31.71	\$31.33	\$28.83	\$31.78

5. The general data on working conditions are taken from the 2010-2013 sector-based collective agreements of the four construction industry sectors, and from the following document, published by the Commission de la construction du Québec: *Carrières construction*, 2010-2011 edition.

Vacations and time off

Mandatory annual holidays of four weeks – two weeks in summer and two in winter at periods predetermined in collective agreements – are the general rule in the construction industry. To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow certain possibilities for changing the vacation periods prescribed by the general rule. Thus, as the participants reported, it happens very frequently that shovel operators working in the civil engineering and roads sector in the summer take their annual summer vacation at a different time and work more hours than is the general rule.

To these vacation periods are added eight not worked statutory holidays, as well as a lump sum for sick leaves not otherwise paid.

Pension plan

Construction industry workers participate in a pension plan. They retain their eligibility for this pension plan throughout their career in construction, even if they change employer, trade or sector.

Insurance

The group insurance plan (medications, illness, disability, death) is fully paid by employers. Workers (and their families, as the case may be) are eligible for it so long as they remain active in the construction industry and work the required number of hours, whether or not they change employer.

Physical requirements

According to the participants, the trade does not require great physical strength, but some activities, such as installing accessories or cleaning the shovel, can be physically demanding.

However, the participants think that shovel operators mainly must demonstrate excellent physical coordination, good mental skills and resistance to stress. Indeed the work requires a high level of concentration.

Work schedules

A 40-hour work week from Monday to Friday is the general rule in all construction industry sectors. The daily limit is 8 hours a day, except in the light residential sector, where it can be up to 10 hours within a 40-hour week. A specific rule is provided for a series of jobs in the civil engineering and roads sector, in which the regular work week is 45 hours, from Monday to Friday.

To avoid penalizing employers and employees experiencing special constraints, the industry's four collective agreements allow many possibilities for changing the schedule prescribed by the general rule: compressed schedule, schedule shift, make-up time in the light residential sector, etc. These possible modifications confer flexibility to the work schedules in effect in the construction industry.

According to the participants, operators generally work in the daytime, but may have to work in the evening, at night or in the weekend according to the type of work to do. It is mentioned, for example, that demolition is done mainly at night and that some work on large civil engineering and roads construction sites are sometimes organized in shifts.

Moreover, shovel operators now work year-long, although the peak period is summer and the slow period is in January and February.

However, it was pointed out that excavation work in wetlands and in certain types of clay soils is better done in winter because of frost.

Stress factors

The shovel operator trade involves many sources of stress. Here are stress factors mentioned by the shovel operators attending the analysis workshop:

- risks of hitting nearby people;
- risks related to the presence of infrastructures (for example, the risks of breaking piping systems and causing a gas leak);
- risks of accidents related to excavation work, such as burials, walls collapsing, etc.;

- coordinating the work (availability of materials, and presence or absence of other heavy equipment);
- bucket size, because working with a Class AA shovel requires greater concentration;
- working under pressure and with tight deadlines;
- productivity requirements.

1.7 WORK ORGANIZATION

The participants report that shovel operators in the civil engineering and roads sector often work in teams of two. Those work teams are comprised of a person responsible for excavating the trench and installing underground infrastructures (called “shovel 1”) and a person responsible for backfilling (called “shovel 2”). In those situations, the “shovel 1” operator must pay attention to his environment, because several persons are in the vicinity. The “shovel 2” operator must be meticulous.

1.8 JOB MARKET ENTRY CONDITIONS⁶

To obtain the competency certificate-apprentice in the trade (CCA), candidates must present to the CCQ the original version of an academic transcript or apprenticeship transcript attesting that they have passed the course of study – for the DEP in “Conduite d’engins de chantier” – recognized by the CCQ and giving access to the industry, as well as a guarantee of employment from an employer registered with the CCQ for at least 150 hours within a period of not more than three consecutive months.

Although the construction industry favours graduates for access to the trade, labour shortages may at times make it necessary to admit shovel operators without a diploma.

6. Other conditions than those listed above may apply. For a complete list of conditions for entering the trade, see the Act respecting labour relations, vocational training and workforce management in the construction industry (R.S.Q., c. R-20). You can also consult the CCQ’s website:
http://www.ccq.org/E_CertificatsCompetence.aspx?sc_lang=en&profil=DevenirTravailleur.

Thus, candidates without a diploma⁷ are eligible to obtain a competency certificate-apprentice only during a labour shortage and must:

- supply proof that they have the academic prerequisites for the program leading to a vocational studies diploma (DEP) in the trade referred to in the application or pledge, by signing a consent letter, to take the necessary training to obtain a DEP;
- present a guarantee of employment produced during a labour-pool opening by an employer registered with the CCQ, for at least 150 hours over a period of at most three consecutive months.

An apprentice shovel operator must have completed an apprenticeship period of 2,000 hours in his trade, in order to be eligible for the provincial qualification examination that leads to obtaining the competency certificate-journeyman for the trade. Credits are paid into the apprenticeship record book of an apprentice shovel operator who has obtained his diploma.

Moreover, certain qualities are sought by employers hiring shovel operators. The following list presents the main qualities, in the order they were mentioned and not in order of importance:

- experience;
- productivity;
- reputation;
- punctuality;
- availability;
- ability to plan or anticipate operations to be performed;
- ability to work under pressure.

7. Of the 11 operators participating in the workshop, 3 have taken the training in heavy equipment operation.

1.9 PLACE OF WOMEN IN THE TRADE

Section 126.0.1 of the Act respecting labour relations, vocational training and workforce management in the construction industry pertains to women's access to the construction industry: "The Commission, after consultation with the Commission des droits de la personne et des droits de la jeunesse, shall develop measures to favour the access of women to and their maintenance and greater representation on the labour market in the construction industry."

According to the CCQ, 21 women were working as shovel operators in 2009 (out of a total of 5,698 shovel operators, i.e., a proportion of almost 0.37%).

According to the shovel operators attending the analysis workshop, the low number of women may be explained by persistent prejudice and the fact that many construction sites do not have nearby sanitary facilities. It is thus often difficult to be absent from one's workstation – in the view of some, this is a disadvantage to women in terms of productivity.

1.10 CAREER PROSPECTS

With experience, shovel operators can become senior operators, foremen, project managers, contractors or teachers.

It was mentioned that the current shortage of shovel operators may be to the disadvantage of the best ones who seek career advancement, because companies want to keep them as operators and do not always give them the opportunity to become foremen, for example.

1.11 DEVELOPMENT OF THE TRADE

In recent years, technological developments have changed the operation of shovels. Now there are sensors, rotary lasers, GPS systems equipped with viewing screens and cameras for underwater excavations. Those various systems transmit real-time data on work in progress, particularly regarding position, elevations, slopes and alignments.

Those new technologies are being implemented unevenly. Some operators still work with lines and levels, but a large number of shovels are now equipped with laser receivers.

Although GPS systems are seen more rarely, and then usually on large construction sites, the operators attending the analysis workshop estimate that those systems will be used more and more frequently in coming years.

Moreover, the use of shovels is diversifying. They can replace several other types of machines for a variety of work. In addition, their performance and precision have improved, and the cab is more comfortable due to heating and air conditioning systems. The field of vision has also greatly improved.

New accessories have also appeared, notably for demolition work. We now find pliers, shearers or sprayers fastened to the machines' arms. Demolition and rebuilding work is indeed more frequent.

These technological changes make work more precise and force operators to be more productive and versatile.

1.12 IMPACT OF ENVIRONMENTAL STANDARDS ON THE PRACTICE OF THE TRADE

The participants reported increasing environmental concerns and nuisance control in the performance of tasks. Accordingly, they observe more and more:

- installation of protective walls for demolition work;
- construction of sedimentation barriers to control soil migration;
- application of wetland protection measures;
- land decontamination work coordinated by an environmental inspector indicating contaminated soil sorting operations to be performed;
- recovery of demolition debris;
- etc.

Environmental concerns require the operator to organize his work differently (for example, the operator no longer has the right to bury concrete, trees, etc.). Production stops for environmental reasons are also more frequent.

2. WORK DESCRIPTION

2.1 TASKS AND OPERATIONS

List of tasks

The following list presents the main tasks performed by shovel operators. The order in which the tasks are presented does not necessarily reflect their importance in the trade.

- Task 1 Do site preparation work
- Task 2 Do excavation work with a hydraulic and mechanical clamshell attachment⁸
- Task 3 Do demolition work
- Task 4 Do excavation work for foundations
- Task 5 Do excavation work in water
- Task 6 Load trucks
- Task 7 Excavate trenches and install utilities
- Task 8 Do finish work

The table of shovel operators' tasks and operations is presented in the following pages.

8. Read in Annex 3 the shovel operator professional subcommittee's comment about task 2.

Table 2.1 Tasks and Operations

TASKS	OPERATIONS					
1. DO SITE PREPARATION WORK	1.1 Plan the work	1.2 Prepare the shovel	1.3 Install accessories	1.4 Clear the land	1.5 Strip the land	1.6 Do decontamination work
	1.7 Participate in dynamiting work	1.8 Build construction site accesses and bypasses	1.9 Install trailers or containers on the construction site	1.10 Put the shovel in the stop position	1.11 Clean the shovel	
2. DO EXCAVATION WORK WITH A HYDRAULIC AND MECHANICAL CLAMSHELL ATTACHMENT	2.1 Plan the work	2.2 Prepare the shovel	2.3 Position and stabilize the shovel	2.4 Pick materials up or dig into the ground	2.5 Deposit the materials or load trucks	2.6 Put the shovel in the stop position
	2.7 Clean the shovel					
3. DO DEMOLITION WORK	3.1 Plan the work	3.2 Prepare the shovel	3.3 Install accessories	3.4 Do a partial or total demolition	3.5 Sort debris and load trucks or containers	3.6 Clear and demolish the foundations
	3.7 Backfill the excavation	3.8 Put the shovel in the stop position	3.9 Clean the shovel			
4. DO EXCAVATION WORK FOR FOUNDATIONS	4.1 Unload the shovel from the flood	4.2 Plan the work	4.3 Prepare the shovel	4.4 Install accessories	4.5 Position and stabilize the shovel	4.6 Reconnoiter the area
	4.7 Proceed to excavate	4.8 Dispose of materials	4.9 Do drainage work, if applicable	4.10 Level the bottom	4.11 Put the shovel in the stop position	4.12 Clean the shovel
	4.13 Load the shovel on the long-load dolly					
5. DO EXCAVATION WORK IN WATER	5.1 Plan the work	5.2 Prepare the shovel	5.3 Install accessories	5.4 Do excavation work on a barge	5.5 Do excavation work from a coffer dam	5.6 Clean the shovel

TASKS	OPERATIONS					
6. LOAD TRUCKS	6.1 Plan the work	6.2 Prepare the shovel	6.3 Prepare the path for trucks	6.4 Position and stabilize the shovel	6.5 Proceed to load	6.6 Put the shovel in the stop position
	6.7 Clean the shovel					
7. EXCAVATE TRENCHES AND INSTALL UTILITIES	7.1 Plan the work	7.2 Prepare the shovel	7.3 Install accessories	7.4 Position and stabilize the shovel	7.5 Clean the work environment	7.6 Unload pipes and manholes
	7.7 Detect buried obstacles	7.8 Proceed to excavate the trench	7.9 Install one or more safety cages (propping), if applicable	7.10 Level the bottom of the trench	7.11 Lower and position pipes and manholes	7.12 Backfill the trench
	7.13 Put the shovel in the stop position	7.14 Clean the shovel				
8. DO FINISH WORK	8.1 Plan the work	8.2 Prepare the shovel	8.3 Install accessories	8.4 Position and stabilize the shovel	8.5 Excavate the ditch	8.6 Reshape existing ditches
	8.7 Stabilize the ends of culverts	8.8 Shape the banks	8.9 Put the shovel in the stop position	8.10 Clean the shovel		

2.2 OPERATIONS, SUB-OPERATIONS AND CLARIFICATIONS

In the following pages are presented sub-operations related to some of the operations, as well as a few clarifications made by the participants.

Table 2.2 Sub-Operations and Operation Clarifications

TASK 1 DO SITE PREPARATION WORK		
Results of the work: clearing, topsoil stripping, decontamination work, dynamiting work, construction of site accesses and bypasses.		
Operations	Sub-Operations	Clarifications
1.1 Plan the work	1.1.1 Read the plans 1.1.2 Learn from the foreman about the nature of the work 1.1.3 Read Info-Excavation data 1.1.4 Locate survey stakes 1.1.5 Locate overhead obstacles	
1.2 Prepare the shovel	1.2.1 Check fluid levels 1.2.2 Add fluids as necessary 1.2.3 Check the condition of components 1.2.4 Report defects 1.2.5 Activate the safety system, if applicable 1.2.6 Start the shovel	
1.3 Install accessories	1.3.1 Remove the fastener 1.3.2 Remove the accessory 1.3.3 Install the new accessory: <ul style="list-style-type: none"> • brush cutter • comb • buckets (ditch, toothed, V-shaped) • grapple • ripper • shear • hydraulic jackhammer 	
1.4 Clear the land	1.4.1 Remove the brush 1.4.2 Cut the branches 1.4.3 Cut down the trees	

TASK 1 DO SITE PREPARATION WORK

Operations		Sub-Operations	Clarifications
1.5	Strip the land	1.5.1 Crush the stubs with the brush cutter 1.5.2 Remove the stubs 1.5.3 Remove the organic soil 1.5.4 Remove the rocks 1.5.5 Sort materials and stack them	
1.6	Do decontamination work	1.6.1 Excavate contaminated soils 1.6.2 Remove contaminated objects 1.6.3 Sort the soils by contamination level and stack them 1.6.4 Load trucks 1.6.5 After the membrane is installed, backfill the excavation	The ground may be contaminated too deeply. In that case, install a membrane and backfill the excavation. The contamination level is determined by an expert who indicates the necessary sort to the operator.
1.7	Participate in dynamiting work	1.7.1 Spread the blasting mat 1.7.2 After the blast, remove the mat 1.7.3 Descale the walls 1.7.4 Strip the top berm ⁹ 1.7.5 Sort the rock 1.7.6 Load trucks	
1.8	Build construction site accesses and bypasses	1.8.1 Proceed to excavate the infrastructure 1.8.2 Backfill the excavation with aggregate 1.8.3 Build the slopes 1.8.4 Do drainage work, if applicable 1.8.5 Install temporary culverts	
1.9	Install trailers or containers on the construction site	1.9.1 Prepare the installation area 1.9.2 Place the trailers or containers	
1.10	Put the shovel in the stop position		
1.11	Clean the shovel		Working in clay soil requires substantial cleaning. In those situations, the operator may be helped by a labourer.

9. A berm is a subhorizontal strip of land at the bottom or crest of a rock slope: translation of "La berme est la bande de terrain subhorizontale située au pied ou en crête d'un talus rocheux." *Lexique – Normes: ouvrages routiers*, ministère des Transports, Direction du soutien aux opérations, June 2010.)

TASK 2 DO EXCAVATION WORK WITH A HYDRAULIC AND MECHANICAL CLAMSHELL ATTACHMENT

Results of the work: dredging, well, stacking and moving stacks.

OPERATIONS	Sub-Operations	Clarifications
2.1 Plan the work	2.1.1 Read the plans 2.1.2 Learn from the foreman about the nature of the work 2.1.3 Read Info-Excavation data 2.1.4 Locate survey stakes 2.1.5 Locate overhead obstacles	
2.2 Prepare the shovel	2.2.1 Check fluid levels 2.2.2 Add fluids as necessary 2.2.3 Check the condition of components 2.2.4 Report defects 2.2.5 Activate the safety system, if applicable 2.2.6 Start the shovel	
2.3 Position and stabilize the shovel	2.3.1 Go to the work location 2.3.2 Install the support and stabilization mat, if applicable 2.3.3 Stabilize the shovel	
2.4 Pick materials up or dig into the ground		
2.5 Deposit the materials or load trucks		
2.6 Put the shovel in the stop position		
2.7 Clean the shovel		

TASK 3 DO DEMOLITION WORK

Results of the work: total or partial demolition of infrastructural elements (such as bridges), buildings or plants.
 Drilling and crushing infrastructural or structural elements.
 Demolition work may also be done on a barge.

Operations	Sub-Operations	Clarifications
3.1 Plan the work	3.1.1 Read demolition plans and specifications 3.1.2 Learn from the foreman about the nature of the work 3.1.3 Check the location 3.1.4 Read Info-Excavation data 3.1.5 Locate overhead obstacles	
3.2 Prepare the shovel	3.2.1 Check fluid levels 3.2.2 Add fluids as necessary 3.2.3 Check the condition of components 3.2.4 Report defects 3.2.5 Activate the safety system, if applicable 3.2.6 Start the shovel	
3.3 Install accessories	3.3.1 Remove the fastener 3.3.2 Remove the accessory 3.3.3 Install the new accessory: <ul style="list-style-type: none"> • shear • pliers • hydraulic jackhammer • demolition shear • hydraulic chisel • sprayer • drills or bits • buckets (toothed and ditch) • grapple • other 	

TASK 3 DO DEMOLITION WORK

OPERATIONS	Sub-Operations	Clarifications
3.4 Do a partial or total demolition	3.4.1 Make sure there are no persons in the vicinity <u>Example of a sequence of operations for a building</u> 3.4.2 Break the windows, if applicable 3.4.3 Demolish the roof 3.4.4 Demolish the walls 3.4.5 Demolish the lower parts 3.4.6 Demolish while moving forward <u>Example of means used</u> 3.4.7 Push walls 3.4.8 Pull walls 3.4.9 Drill a surface 3.4.10 Undermine a structure 3.4.11 Smash a surface 3.4.12 Crush materials 3.4.13 Shear materials 3.4.14 Grind materials	Partial demolition applies to a variety of rebuilding work (such as an overpass structure). Several demolition methods or techniques exist. Operators must follow a sequence of operations and use various means to do so.
3.5 Sort debris and load trucks or containers		
3.6 Clear and demolish the foundations		
3.7 Backfill the excavation		
3.8 Put the shovel in the stop position		
3.9 Clean the shovel		

TASK 4 DO EXCAVATION WORK FOR FOUNDATIONS

Results of the work: excavations for residential, institutional, commercial and industrial buildings.

OPERATIONS		Sub-Operations	Clarifications
4.1	Unload the shovel from the fload	4.1.1 Check the premises 4.1.2 Lower the shovel from the long-load dolly	The shovel may be unloaded from the long-load dolly for all of the profession's tasks. However, the operators attending the occupational analysis workshop deemed it preferable to associate this operation, as well as the shovel loading operation, to this task because foundation excavation may be done several times during a work week.
4.2	Plan the work	4.2.1 Read the plans 4.2.2 Learn from the foreman about the nature of the work 4.2.3 Read Info-Excavation data 4.2.4 Locate survey stakes 4.2.5 Locate overhead obstacles	
4.3	Prepare the shovel	4.3.1 Check fluid levels 4.3.2 Add fluids as necessary 4.3.3 Check the condition of components 4.3.4 Report defects 4.3.5 Activate the safety system, if applicable 4.3.6 Start the shovel	
4.4	Install accessories	4.4.1 Remove the fastener 4.4.2 Remove the accessory 4.4.3 Install the new accessory: <ul style="list-style-type: none"> • buckets (toothed and ditch) • ripper • hydraulic jackhammer 	

TASK 4 DO EXCAVATION WORK FOR FOUNDATIONS

OPERATIONS		Sub-Operations		Clarifications
4.5	Position and stabilize the shovel	4.5.1	Go to the work location	
		4.5.2	Install the support and stabilization mat, if applicable	
		4.5.3	Stabilize the shovel	
4.6	Reconnoiter the area	4.6.1	Dig	
		4.6.2	Check the type of aggregate or soils	
		4.6.3	Detect obstacles, old infrastructures and buried utilities	
4.7	Proceed to excavate	4.7.1	Determine the sequence of operations to be performed	Excavations serve to build walls, pillars, pilasters, footings, floors, service entrances, etc.
		4.7.2	Dig into the ground	
		4.7.3	Secure the slopes	
		4.7.4	Remove obstacles	
		4.7.5	Undo old infrastructures	
		4.7.6	Have the municipality's inspector come to connect utilities (aqueduct, sanitary and storm sewers)	
4.8	Dispose of materials	4.8.1	Sort materials	
		4.8.2	Stack materials	
		4.8.3	Load trucks	
4.9	Do drainage work, if applicable	4.9.1	Dig a gutter or a catch drain	
		4.9.2	Lower a pump, if applicable	
		4.9.3	Add drainage materials, if applicable	
4.10	Level the bottom	4.10.1	Adjust the level	
		4.10.2	Add aggregate, if applicable	
		4.10.3	Lower the vibrating plate (for the labourer)	
		4.10.4	Raise the vibrating plate	
4.11	Put the shovel in the stop position			
4.12	Clean the shovel			Working in clay soil requires substantial cleaning. In those situations, the operator may be helped by a labourer.
4.13	Load the shovel on the long-load dolly	4.13.1	Check the loading area	
		4.13.2	Mount the shovel on the long-load dolly	

TASK 5 DO EXCAVATION WORK IN WATER

Results of the work: lower water grade level, excavation for pillar, excavation for passage of pipes or cables, discharge of materials.

OPERATIONS		Sub-Operations	Clarifications
5.1	Plan the work	5.1.1 Read the plans 5.1.2 Learn from the foreman about the nature of the work 5.1.3 Locate the survey markers	
5.2	Prepare the shovel	5.2.1 Check fluids level 5.2.2 Add fluids if necessary 5.2.3 Check components condition 5.2.4 Report defects 5.2.5 Activate the safety system, if applicable 5.2.6 Start the shovel	
5.3	Install accessories	5.3.1 Remove the fastener 5.3.2 Remove the accessory 5.3.3 Install the new accessory: <ul style="list-style-type: none"> • buckets (toothed and ditch) • comb • clamshell attachment 	
5.4	Do excavation work on a barge	5.4.1 Check the barge 5.4.2 Install the mat, if applicable 5.4.3 Mount the shovel on the barge 5.4.4 Position the shovel 5.4.5 Secure the shovel, if applicable 5.4.6 Position the loading barge 5.4.7 Excavate 5.4.8 Deposit materials on the loading barge 5.4.9 Put the shovel in the stop position 5.4.10 Lower the shovel from the barge	
5.5	Do excavation work from a coffer dam	5.5.1 Prepare the ground 5.5.2 Install a membrane on the bottom of the coffer dam to be built 5.5.3 Build the coffer dam 5.5.4 Install membranes on the sides 5.5.5 Excavate 5.5.6 Load trucks 5.5.7 Undo the coffer dam 5.5.8 Put the shovel in the stop position	
5.6	Clean the shovel		

TASK 6 LOAD TRUCKS

OPERATIONS		Sub-Operations		Clarifications
6.1	Plan the work	6.1.1	Find out about the loading plan	
		6.1.2	Learn from the foreman about the nature of the work	
		6.1.3	Learn about the type of soils or the nature of the rubble	
		6.1.4	Check the work area	
		6.1.5	Locate overhead obstacles	
6.2	Prepare the shovel	6.2.1	Check fluids level	
		6.2.2	Add fluids if necessary	
		6.2.3	Check components condition	
		6.2.4	Report defects	
		6.2.5	Activate the safety system, if applicable	
		6.2.6	Start the shovel	
6.3	Prepare the path for trucks	6.3.1	Stabilize the ground	
		6.3.2	Level the ground	
		6.3.3	Compact the ground with the tracks or the bucket	
6.4	Position and stabilize the shovel	6.4.1	Go to the loading area	
		6.4.2	Build a shovel platform, if applicable	
		6.4.3	Stabilize the shovel	
6.5	Proceed to load	6.5.1	Locate the trucks	
		6.5.2	Direct the trucks	
6.6	Put the shovel in the stop position			
6.7	Clean the shovel			

TASK 7 EXCAVATE TRENCHES AND INSTALL UTILITIES

Results of the work: sewers, aqueduct, gas lines, as well as electric, telephone and telecommunication wires.

This task is described for the simultaneous work of two shovel operators (shovels 1 and 2). The shovel 1 operator is responsible for the excavation, trench preparation and utility installation. The shovel 2 operator is responsible for the backfill. Generally, the shovel 1 operator is more experienced and must pay close attention to buried infrastructures and the eventual presence of persons in the vicinity and at the bottom of the excavation.

OPERATIONS		Sub-Operations	Clarifications
7.1	Plan the work	7.1.1 Read the plans 7.1.2 Learn from the foreman about the nature of the work 7.1.3 Read Info-Excavation data 7.1.4 Locate survey stakes 7.1.5 Locate overhead obstacles	
7.2	Prepare the shovel	7.2.1 Check fluids level 7.2.2 Add fluids if necessary 7.2.3 Check components condition 7.2.4 Report defects 7.2.5 Activate the safety system, if applicable 7.2.6 Start the shovel	
7.3	Install accessories	7.3.1 Remove the fastener 7.3.2 Remove the accessory 7.3.3 Install the new accessory: <ul style="list-style-type: none"> • ripper • V-shaped, ditch and toothed buckets 	
7.4	Position and stabilize the shovel	7.4.1 Go to the work location 7.4.2 Install the support and stabilization mat, if applicable 7.4.3 Stabilize the shovel	
7.5	Clean the work environment	7.5.1 Remove detrimental materials and objects 7.5.2 Load the trucks	
7.6	Unload pipes and manholes	7.6.1 Estimate the load 7.6.2 Choose the location 7.6.3 Proceed to the slinging 7.6.4 Position the pipes or manholes	

TASK 7 EXCAVATE TRENCHES AND INSTALL UTILITIES

OPERATIONS		Sub-Operations	Clarifications
7.7	Detect buried obstacles	7.7.1 Dig 7.7.2 Locate buried pipes and manholes 7.7.3 Adjust the work according to the existing network	
7.8	Proceed to excavate the trench	7.8.1 Determine the sequence of operations to be performed 7.8.2 Dig into the ground 7.8.3 Secure the walls 7.8.4 Remove existing pipes and manholes, if applicable	
7.9	Install one or more safety cages (propping), if applicable	7.9.1 Excavate at the location of the installation 7.9.2 Lower the safety or prop cage(s)	
7.10	Level the bottom of the trench	7.10.1 Adjust the level 7.10.2 Add aggregate 7.10.3 Lower the vibrating plate 7.10.4 Raise the vibrating plate	
7.11	Lower and position pipes and manholes	7.11.1 Estimate the load 7.11.2 Proceed to the slinging 7.11.3 Position the pipes or manholes	
7.12	Backfill the trench	7.12.1 Check the composition of soil layers 7.12.2 Place the rubble according to specifications	
7.13	Put the shovel in the stop position		
7.14	Clean the shovel		Working in clay soil requires substantial cleaning. In those situations, the operator may be helped by a labourer.

TASK 8 DO FINISH WORK

Results of the work: bank, dike and dam.

OPERATIONS		Sub-Operations		Clarifications
8.1	Plan the work	8.1.1	Read the plans	
		8.1.2	Learn from the foreman about the nature of the work	
		8.1.3	Read Info-Excavation data	
		8.1.4	Locate survey stakes	
		8.1.5	Locate overhead obstacles	
8.2	Prepare the shovel	8.2.1	Check fluids level	
		8.2.2	Add fluids if necessary	
		8.2.3	Check components condition	
		8.2.4	Report defects	
		8.2.5	Activate the safety system, if applicable	
		8.2.6	Start the shovel	
8.3	Install accessories	8.3.1	Remove the fastener	
		8.3.2	Remove the accessory	
		8.3.3	Install the new accessory: <ul style="list-style-type: none"> • buckets (V-shaped, ditch and toothed) • hydraulic jackhammer (rarely) 	
8.4	Position and stabilize the shovel	8.4.1	Go to the work location	
		8.4.2	Install the support and stabilization mat, if applicable	
		8.4.3	Stabilize the shovel	
8.5	Excavate the ditch	8.5.1	Dig into the ground	
		8.5.2	Level the bottom	
		8.5.3	Shape the ditch	
8.6	Reshape existing ditches	8.6.1	Secure the walls	
		8.6.2	Redo the shape with organic soil	
8.7	Stabilize the ends of culverts	8.7.1	Install the geotextile	
		8.7.2	Install the gabions or riprap	
8.8	Shape the banks	8.8.1	Spread organic soil	
		8.8.2	Level the surface	
		8.8.3	Flatten the surface with the bucket	

TASK 8 DO FINISH WORK

OPERATIONS	Sub-Operations	Clarifications
8.9 Put the shovel in the stop position		
8.10 Clean the shovel		

2.3 ACHIEVEMENT CONDITIONS AND PERFORMANCE CRITERIA**2.3.1 ACHIEVEMENT CONDITIONS**

Data on achievement conditions were collected for the shovel operator trade as a whole. The data pertain to aspects such as work areas, level of collaboration, work instructions, reference documents consulted, material resources used, and health and safety hazards.

In Annex 1 is a list of tools and equipment used for each task.

Table 2.3 Achievement Conditions

TASK 1 DO SITE PREPARATION WORK

<p>Workplaces</p> <p>On the construction site. Outdoors.</p>
<p>Level of collaboration</p> <p>In a team. Under the foreman's supervision.</p>
<p>Instructions and references</p> <p>From plans, contractor instructions, Info-Excavation data and survey data. Following notices by the environmental inspector.</p>
<p>Raw materials used</p> <p>Aggregate and sand.</p>
<p>Materials discharged</p> <p>Clearing debris, organic soil, mineral soil, stones, blast debris and contaminated soil.</p>
<p>Health and safety hazards</p> <p>In a context that poses risks of:</p> <ul style="list-style-type: none">• electrocution;• equipment overturning;• rock fall;• exposure to dust;• exposure to fumes and gases;• exposure to noises and vibrations;• hitting someone who is near the shovel;• being hit by flying debris;• unforeseen reactions of buried objects;• loss of balance.

TASK 2 DO EXCAVATION WORK WITH A HYDRAULIC AND MECHANICAL CLAMSHELL ATTACHMENT

<p>Workplaces</p> <p>On the construction site. Outdoors and indoors.</p>
<p>Level of collaboration</p> <p>Individually. Under the foreman's supervision.</p>
<p>Instructions and references</p> <p>From plans, contractor instructions, Info-Excavation data and survey data. Following notices by the environmental inspector.</p>
<p>Materials discharged</p> <p>Mud, rocks, earth, sand, etc.</p>
<p>Health and safety hazards</p> <p>In a context that poses risks of:</p> <ul style="list-style-type: none">• electrocution;• equipment overturning;• rock fall;• exposure to dust;• hitting someone who is near the shovel;• hitting the cab with accessories that are oversized or installed on extended arms;• loss of balance.

TASK 3 DO DEMOLITION WORK

<p>Workplaces</p> <p>On the construction site. Outdoors and indoors.</p>
<p>Level of collaboration</p> <p>In a team. Under the foreman's supervision.</p>
<p>Instructions and references</p> <p>From demolition plans and specifications, contractor instructions and Info-Excavation data. Following notices by the environmental inspector.</p>
<p>Recovered materials</p> <p>Aggregate, metal reinforcements and other dry materials.</p>
<p>Health and safety hazards</p> <p>In a context that poses risks of:</p> <ul style="list-style-type: none">• electrocution;• equipment overturning;• rock fall;• exposure to dust;• exposure to fumes and gases;• exposure to noises and vibrations;• hitting someone who is near the shovel;• being hit by debris;• hitting the cab with accessories that are oversized or installed on extended arms;• loss of balance.

TASK 4 DO EXCAVATION WORK FOR FOUNDATIONS

<p>Workplaces</p> <p>On the construction site. Outdoors and indoors.</p>
<p>Level of collaboration</p> <p>Alone and in a team. Under the foreman's supervision.</p>
<p>Instructions and references</p> <p>From plans, contractor instructions, Info-Excavation data and survey data.</p>
<p>Raw materials</p> <p>Aggregate and sand.</p>
<p>Health and safety hazards</p> <p>In a context that poses risks of:</p> <ul style="list-style-type: none">• electrocution;• equipment overturning;• rock fall;• exposure to dust;• exposure to fumes and gases;• exposure to noises and vibrations;• hitting someone who is near the shovel;• loss of balance.

TASK 5 DO EXCAVATION WORK IN WATER

Workplaces

On the construction site.

Outdoors.

Some work can be done in winter on frozen bodies of water. But such work is rarer.

Level of collaboration

In a team.

Under the foreman's supervision.

In collaboration with a diver for some of the excavation work on a barge.

Instructions and references

From specifications, contractor instructions and survey data.

Materials discharged

Mud, rocks, silt, sand, etc.

Health and safety hazards

In a context that poses risks of:

- equipment overturning;
- exposure to noises and vibrations;
- hitting someone who is near the shovel;
- loss of balance.

TASK 6 LOAD TRUCKS

<p>Workplaces</p> <p>On the construction site. Outdoors.</p>
<p>Level of collaboration</p> <p>Alone and in a team. Under the foreman's or client's supervision.</p>
<p>Instructions and references</p> <p>From contractor instructions and the loading plan.</p>
<p>Raw materials</p> <p>Aggregate, sand, organic soil, vegetable soil, demolition debris, other dry materials.</p>
<p>Health and safety hazards</p> <p>In a context that poses risks of:</p> <ul style="list-style-type: none">• electrocution;• equipment overturning;• exposure to dust;• exposure to fumes and gases;• exposure to noises and vibrations;• hitting someone who is near the shovel;• falling or projected debris;• loss of balance.

TASK 7 EXCAVATE TRENCHES AND INSTALL UTILITIES

Workplaces

On the construction site.
Outdoors and indoors.

Level of collaboration

In teams of two shovel operators.
With labourers.
Under the foreman's supervision.

Instructions and references

From plans, contractor instructions, Info-Excavation data and survey data.

Raw materials

Aggregate and sand.

Health and safety hazards

In a context that poses risks of:

- electrocution;
- equipment overturning;
- rock fall;
- exposure to dust;
- exposure to fumes and gases;
- exposure to noises and vibrations;
- hitting someone who is near the shovel;
- loss of balance.

TASK 8 DO FINISH WORK

Workplaces On the construction site. Outdoors.
Level of collaboration In a team. Under the foreman's supervision.
Instructions and references From plans, contractor instructions, Info-Excavation data and survey data.
Raw materials Rocks, aggregate, sand and organic soil.
Health and safety hazards In a context that poses risks of: <ul style="list-style-type: none">• electrocution;• equipment overturning;• exposure to dust;• exposure to noises and vibrations;• hitting someone who is near the shovel;• loss of balance.

2.3.2 PERFORMANCE CRITERIA

Performance criteria were gathered for each task. They are used for assessing whether the tasks were performed satisfactorily. The criteria pertain to aspects such as the quantity and quality of work done, the observance of a work procedure, the attitudes adopted, etc.

To draw the list of criteria for each task, the participants worked in teams. Their results were then collected and presented in full session.

Table 2.4 Performance Criteria

TASK 1 DO SITE PREPARATION WORK	
Performance Criteria	
Using appropriate hand signals	Observing weight lifting standards
Planning operations adequately	Observing slopes
Wearing personal protective equipment	Observing survey data
Constant concentration	Observing elevation levels
Dexterity	Observing rights-of-way
Using the shovel with caution	Respecting the environment
Stable shovel	Observing occupational health and safety rules
Clean shovel	
TASK 2 DO EXCAVATION WORK WITH A HYDRAULIC AND MECHANICAL CLAMSHELL ATTACHMENT	
Performance Criteria	
Using appropriate hand signals	Clean shovel
Planning operations adequately	Observing weight lifting standards
Wearing personal protective equipment	Observing survey data
Constant concentration	Observing elevation levels
Dexterity	Respecting the environment
Using the shovel with caution	Observing occupational health and safety rules
Stable shovel	
TASK 3 DO DEMOLITION WORK	
Performance Criteria	
Using appropriate hand signals	Clean shovel
Interpreting correctly and following the demolition plan	Observing weight lifting standards
Planning operations adequately	Observing slopes
Wearing personal protective equipment	Observing elevation levels
Constant concentration	Observing rights-of-way
Dexterity	Respecting the environment
Using the shovel with caution	Observing occupational health and safety rules
Stable shovel	

TASK 4 DO EXCAVATION WORK FOR FOUNDATIONS	
Performance Criteria	
Using appropriate hand signals	Clean shovel
Planning operations adequately	Observing slopes
Wearing personal protective equipment	Observing survey data
Constant concentration	Observing elevation levels
Dexterity	Observing rights-of-way
Using the shovel with caution	Respecting the environment
Stable shovel	Observing occupational health and safety rules
TASK 5 DO EXCAVATION WORK IN WATER	
Performance Criteria	
Using appropriate hand signals	Clean shovel
Planning operations adequately	Observing weight lifting standards
Communicating clearly with the diver, if applicable	Observing survey data
Wearing personal protective equipment	Observing elevation levels
Constant concentration	Observing rights-of-way
Dexterity	Respecting the environment
Using the shovel with caution	Observing occupational health and safety rules
Stable shovel	
TASK 6 LOAD TRUCKS	
Performance Criteria	
Using appropriate hand signals	Observing weight lifting standards
Planning operations adequately	Observing slopes
Wearing personal protective equipment	Observing elevation levels
Constant concentration	Observing rights-of-way
Dexterity	Following the loading plan
Using the shovel with caution	Respecting the environment
Stable shovel	Observing occupational health and safety rules
Clean shovel	

TASK 7 EXCAVATE TRENCHES AND INSTALL UTILITIES	
Performance Criteria	
Using appropriate hand signals	Clean shovel
Planning operations adequately	Observing weight lifting standards
Cautiously and safely handling the safety cage(s) (propping)	Observing slopes
Wearing personal protective equipment	Observing survey data
Constant concentration	Observing elevation levels
Dexterity	Observing rights-of-way
Using the shovel with caution	Respecting the environment
Stable shovel	Observing occupational health and safety rules
TASK 8 DO FINISH WORK	
Performance Criteria	
Using appropriate hand signals	Clean shovel
Planning operations adequately	Observing weight lifting standards
Wearing personal protective equipment	Observing slopes
Constant concentration	Observing survey data
Dexterity	Observing elevation levels
Using the shovel with caution	Observing rights-of-way
Stable shovel	Respecting the environment
Aesthetic work	Observing occupational health and safety rules

2.4 FUNCTIONS

Functions:

- are a set of related tasks;
- may be defined by the work's results or by a sequence of steps;
- are natural and concrete sets.

For the shovel operator trade, the participants, after examining the tasks according to the definition of “function,” identified the function of excavation for buildings or public works; this function groups tasks 2, 4 and 7 (“Do excavation work with a hydraulic and mechanical clamshell attachment,” “Do excavation work for foundations” and “Excavate trenches and install utilities”).

The participants consider that the other tasks are different and cannot be grouped by affinity.

3. QUANTITATIVE DATA ON TASKS

3.1 OCCURRENCE

Occurrence data concern the percentage of shovel operators¹⁰ who perform a task in the same work environment. The data presented in the tables below are the average results of the workshop participants. However, they account for tasks performed not only by the operators attending the workshop, but also of all shovel operators working in the companies represented.

Table 3.1 Task Occurrence

TASK		Occurrence
1	Do site preparation work	90.6%
2	Do excavation work with a hydraulic and mechanical clamshell attachment	8.3%
3	Do demolition work	31.4%
4	Do excavation work for foundations	81.6%
5	Do excavation work in water	21.8%
6	Load trucks	100.0%
7	Excavate trenches and install utilities	64.0%
8	Do finish work	71.5%

10. Excluding apprentices.

3.2 WORK TIME

Work time, also expressed in percentages, represents the average time allocated to each task by each participant, on an annual basis.

Table 3.2 Work Time Allocated to Each Task

TASK	Work Time
1 Do site preparation work	15.4%
2 Do excavation work with a hydraulic and mechanical clamshell attachment	0.0%
3 Do demolition work	6.2%
4 Do excavation work for foundations	11.2%
5 Do excavation work in water	3.8%
6 Load trucks	12.2%
7 Excavate trenches and install utilities	41.0%
8 Do finish work	10.2%

3.3 IMPORTANCE AND DIFFICULTY OF TASKS

The **importance** of a task is estimated according to the more or less harmful consequences of performing a task poorly or not at all. The importance is assessed according to the following scale:

1. Not important at all: Poor execution of the task has no consequences on the quality of the result, the costs, health and safety, etc.
2. Not very important: Poor execution of the task could lead to minimal costs, an unsatisfactory result, minor injury or accident hazards, etc.
3. Important: Poor execution of the task could lead to substantial additional costs, injuries, accidents, etc.
4. Very important: Poor execution of the task could lead to very serious consequences in terms of costs, safety, etc.

A task's **difficulty** is assessed according to the following scale:

1. Very easy: The task involves little risk of error; it requires no notable physical or mental effort. Performing the task is less difficult than average.
2. Easy: The task involves a few risks of error; it requires minimal physical or mental effort.
3. Difficult: The task involves many risks of error; it requires a good physical or mental effort. Performing the task is more difficult than average.
4. Very difficult: The task involves a high risk of error; it requires substantial physical or mental effort. The task is among the most difficult in the trade.

The data presented in the table below are the average results for the operators who attended the workshop.

Table 3.3 Importance and Difficulty of Tasks

Task		Importance	Difficulty
1	Do site preparation work	2.6	1.3
2	Do excavation work with a hydraulic and mechanical clamshell attachment	2.7	3.2
3	Do demolition work	3.5	2.4
4	Do excavation work for foundations	3.7	2.1
5	Do excavation work in water	3.6	2.8
6	Load trucks	2.4	1.3
7	Excavate trenches and install utilities	3.9	2.6
8	Do finish work	3.8	1.5

4. KNOWLEDGE, SKILLS AND ATTITUDES

The occupational analysis enabled us to specify some of the knowledge, skills and attitudes necessary for performing the tasks. Those qualities are transferable, i.e., applicable to a variety of tasks and situations.

The following pages present the knowledge, skills and attitudes that, according to the participants, are considered essential for performing the tasks of the shovel operator trade.

4.1 KNOWLEDGE

Mathematical knowledge

Use of the four basic operations and the rule of three, as well as knowledge of angles, are necessary in practicing the trade. This mathematical knowledge is useful for:

- observing elevation levels and slopes;
- taking measurements and converting them;
- interpreting survey data;
- transferring batter boards (offsets) to installation points;
- calculating angles and slopes.

Knowledge of soil properties

The ability to recognize mineral materials and types of soil such as clay, organic soil, peat, granite, till, sand, shale and the various types of aggregate is essential to the trade.

The operator must also be able to detect soils that are contaminated, remoulded and of varying density.

This knowledge is used in all of the profession's tasks, particularly for:

- understanding guidelines;
- detecting obstacles;

- choosing the accessory;
- sorting materials;
- anticipating wall reactions and soil behaviours;
- checking the composition of soil layers.

Mechanical knowledge

Basic mechanical knowledge is used for detecting operational problems, operating the machinery in a way that avoids mechanical failures, and being more able to make a work stoppage decision in order to prevent serious mechanical failures.

Using the appropriate vocabulary to describe mechanical components makes it possible to inform mechanics in case of shovel failure.

Knowledge of the physical characteristics of existing public works

Basic knowledge of the characteristics of public works is important to operators doing demolition work.

Survey knowledge

Survey knowledge is useful in all tasks except loading trucks. It enables the operator to do quality work meeting construction requirements. More specifically, this knowledge is used for:

- interpreting data written on survey stakes;
- interpreting data transmitted by electronic systems and components (sensors, rotary lasers and GPS systems, for example);
- observing the chaining, elevation levels and slopes;
- doing alignments;
- transferring batter boards (offsets) to installation points;
- etc.

Plan reading knowledge

Interpreting plans is important in the trade. It enables the operator to find out about the work to be done, locate existing elements (buried or not) and view the result of the work. In demolition situations, interpreting demolition plans is fundamental, in helping determine the sequence of operations and the means to be used.

4.2 SKILLS

Skills are types of know-how. They are divided into three categories: cognitive, motor and perceptual.

4.2.1 Cognitive skills

Cognitive skills pertain to intellectual strategies applied in working. The main cognitive skills that shovel operators need are presented below.

Problem-solving and decision-making

These skills are useful for performing tasks on many occasions, such as:

- estimating the necessary time for doing a job;
- deciding to stop excavation operations in case of danger;
- analysing and correcting errors of execution;
- facing contingencies.

Planning activities

A shovel operator's tasks are at the heart of many types of construction work, and the operator must often sequence a good number of activities (such as excavation, loading trucks and handling equipment) according to the availability of materials and the presence or absence of other heavy equipment. If he stops the shovel, the work of other trades is often affected too. Given that context, the trade requires excellent activity planning skills.

4.2.2 Motor skills

Motor skills involve making gestures and movements.

A shovel contains many types of electronic controls: levers, joysticks, buttons and pedals. Motor skills are thus essential to the practice of the profession, because gestures must be precise due to the sensitivity of those controls. Moreover, using certain accessories may involve using additional buttons or switches.

An operator must also have excellent coordination of his gestures. Head, hands, legs and feet must move in concert to make safe and precise gestures.

A shovel operator must also be able to lift loads of up to 25 kilograms.

4.2.3 Perceptual skills

Perceptual skills are sensory skills enabling a person to perceive by his senses what is happening in his environment.

A shovel operator must have good visual acuity, to perceive certain details when working (buried wires, for example). He must also have excellent peripheral vision, given the many turret movement and the risks of hitting persons, moving vehicles or buildings.

Good hearing is useful, for hearing abnormal noises produced by the shovel, locating moving vehicles and detecting gas or oil leaks.

The participants also pointed out that a good sense of smell is useful for perceiving gas or oil leaks, burning odours, and the presence of contaminated soils.

Finally, the trade obviously requires tactile skills, since perceiving contact and vibrations makes it possible to use electronic controls and feel the shovel's behaviour.

4.3 ATTITUDES

Attitudes are ways of acting, reacting and relating with others or with one's environment. They involve personal skills. The main attitudes that shovel operators need are personal and interpersonal; professional ethics and prevention in occupational health and safety matters are also required.

Personal attitudes

Patience is often necessary to face contingencies, coordinate truck-loading operations or, more simply, wait for work to be completed before the operator can begin tasks with the shovel.

Interpersonal attitudes

A shovel operator must be able to communicate his instructions clearly and be respected by others, because he often has to plan and coordinate the sequence of operations. On many occasions, the operator has to demonstrate leadership.

Professional ethics

The consequences of inattention or error are serious, so the operator must demonstrate professional ethics by recognizing either dangerous situations or signs telling him that he is not in the necessary mental or physical condition to operate the shovel. In those circumstances, it is his duty to communicate that he cannot do the work.

Preventive health and safety attitudes and behaviours

These attitudes and behaviours are observed by:

- alertness and vigilance, to locate persons in the vicinity;
- the ability to anticipate others' behaviour;
- constant communication with co-workers;
- the ability to report an occupational health and safety failure;
- the ability to concentrate.

5. TRAINING SUGGESTIONS

The shovel operators attending the occupational analysis workshop made suggestions about initial school training, the apprenticeship period, and the training of journeymen.

With regard to initial school training and the apprenticeship period, the participants made the following suggestions:

- integrate, within the study program, a training period in the workplace;
- ask teaching institutions to use the pedagogical formula of alternating work and studies;
- improve the partnership between vocational training centres and companies;
- simulate construction site work to a greater extent during school training;
- introduce new technologies;
- pair apprentices with experienced operators during the apprenticeship period;
- lengthen the apprenticeship period, currently 2,000 hours.

With regard to the training of journeymen, the participants asked that the Commission de la construction du Québec:

- develop a training program in the new electronic systems;
- ensure that operators receive the necessary training in electrical hazards;
- establish courses on the various demolition methods, the use of accessories, the interpretation of demolition plans, and the hazards involved in major demolition work.

Annexes

Annex 1 Tools and Equipment

For each task of the shovel operator trade, and from a list submitted to them¹¹, the participants identified the tools and equipment they use: accessories, devices, construction machines and engines; tools and instruments; accessories and light equipment; raw materials; small tools and accessories; safety equipment and accessories.

Table A.1 Tools and Equipment

TASK 1 DO SITE PREPARATION WORK	
Accessories	
Hydraulic jackhammer (rock-breaker)	Buckets (toothed, ditch, V-shaped)
Shear	Comb
Brush cutter	
Ripper	
Construction devices, machines and engines	
Electronic ranger limiter	Mobile radio
Tools and instruments	
Sockets	Square shovel
Sledge hammer	
Raw materials	
Diesel fuel	Hydraulic oil
Absorbent paper towel	Windshield wiper fluid
Workshop paper towel	Hand cleaner
Grease	Window cleaner
Oil (diesel engine)	
Small tools and accessories	
Sledge hammer	Grease gun
Narrow shovel	Flat tip screwdriver

11. This list had been prepared by the CCQ and the content expert according to the list of tools and equipment in the occupational analysis of the heavy machinery operator trade.

TASK 1 DO SITE PREPARATION WORK	
Safety equipment and accessories	
Safety boots	Safety glasses
Hard hat	First aid kit
Fire extinguisher (ABC type)	Road safety vest
Gloves	
TASK 2 DO EXCAVATION WORK WITH A HYDRAULIC AND MECHANICAL CLAMSHELL ATTACHMENT	
Construction devices, machines and engines	
Electronic ranger limiter	
Tools and instruments	
Adjustable wrench	Sockets
Ratchet wrench	Sledge hammer
Raw materials	
Diesel fuel	Gear oil
Absorbent paper towel	Hydraulic oil
Workshop paper towel	Windshield wiper fluid
Grease	Hand cleaner
Oil (diesel engine)	Window cleaner
Small tools and accessories	
Bolts	Narrow shovel
Flexible hose	Grease gun
Nuts	
Safety equipment and accessories	
Safety boots	Gloves
Hard hat	Road safety vest
Fire extinguisher (ABC type)	
TASK 3 DO DEMOLITION WORK	
Accessories	
Hydraulic jackhammer	Ripper
Shear	Drills or bits
Hydraulic shear	Buckets (toothed and ditch)
Demolition shear	Sprayer

TASK 3 DO DEMOLITION WORK	
Construction devices, machines and engines	
Electronic ranger limiter	Portable radio
Mobile radio	
Tools and instruments	
Adjustable wrench	Sockets
Ratchet wrench	Sledge hammer
Portable air compressor (for drilling)	Measuring tape
Impact socket	
Light accessories and equipment	
Coupled rubber hose (for drilling)	Sling (wire-rope)
Air hosing (for drilling)	Electrode holder
Raw materials	
Diesel fuel	Drilling oil
Absorbent paper towel	Hydraulic oil
Workshop paper towel	Windshield wiper fluid
Grease	Hand cleaner
Oil (diesel engine)	Window cleaner
Gear oil	
Small tools and accessories	
Flexible hose	Dowel pins
Wire rope	Narrow shovel
Nylon rope	Grease gun
All-purpose rings	Flat tip screwdriver
Sling (wire-rope)	
Safety equipment and accessories	
Safety boots	Gloves
Hard hat	Hearing protector
Fire extinguisher (ABC type)	Road safety vest

TASK 4 DO EXCAVATION WORK FOR FOUNDATIONS	
Accessories	
Ripper	Hydraulic jackhammer
Buckets (toothed and ditch)	
Construction devices, machines and engines	
Rotary laser	Rotary laser receiver
Tools and instruments	
Marker	Square shovel
Tripod level	Measuring tape
Raw materials	
Diesel fuel	Oil (diesel engine)
Essence	Hydraulic oil
Absorbent paper towel	Windshield wiper fluid
Workshop paper towel	Hand cleaner
Grease	Window cleaner
Small tools and accessories	
Tie wrap	Narrow shovel
Sledge hammer	Grease gun
Safety equipment and accessories	
Safety boots	Safety glasses
Hard hat	Hearing protector
Fire extinguisher (ABC type)	Road safety vest
Gloves	
TASK 5 DO EXCAVATION WORK IN WATER	
Accessories	
Clamshell attachment	Comb
Buckets (toothed and ditch)	
Construction devices, machines and engines	
Camera and television screen	Mobile radio
Rotary laser	Portable radio
Electronic level	Rotary laser receiver

TASK 5 DO EXCAVATION WORK IN WATER	
Tools and instruments	
Adjustable wrench	Sledge hammer
Ratchet wrench	Tripod level
Sockets	
Raw materials	
Diesel fuel	Gear oil
Absorbent paper towel	Hydraulic oil
Workshop paper towel	Windshield wiper fluid
Grease	Hand cleaner
Oil (diesel engine)	Window cleaner
Small tools and accessories	
Bolts	Nuts
Flexible hose	Sling (wire-rope)
Wire rope	Narrow shovel
Nylon rope	Grease gun
Safety equipment and accessories	
Safety boots	Warning horn
Life buoy	Hearing protector
Hard hat	FM communications radio
Fire extinguisher (ABC type)	Floater vest
Gloves	Road safety vest
TASK 6 LOAD TRUCKS	
Accessories	
Buckets (toothed and ditch)	
Construction devices, machines and engines	
Electronic ranger limiter	
Raw materials	
Diesel fuel	Oil (diesel engine)
Absorbent paper towel	Hydraulic oil
Workshop paper towel	Windshield wiper fluid
Grease	Hand cleaner

TASK 6 LOAD TRUCKS	
Small tools and accessories	
Sledge hammer	Grease gun
Narrow shovel	
Safety equipment and accessories	
Safety boots	Safety glasses
Hard hat	Hearing protector
Fire extinguisher (ABC type)	First aid kit
Gloves	Road safety vest
TASK 7 EXCAVATE TRENCHES AND INSTALL UTILITIES	
Accessories	
Ripper	Buckets (toothed, ditch, V-shaped)
Construction devices, machines and engines	
Service truck	Rotary laser receiver
LD series reinforcement bunker	Mobile radio
Rotary laser	Portable radio
Electronic ranger limiter	Sewer manhole
Pipe pliers	Winch
Tools and instruments	
Angled pry bar	Square shovel
Marker	Crowbar
Sledge hammer	Retaining ring pliers
Cutting wheel (abrasive saw)	Circlip pliers
Target	Angle grinder
Tripod level	Measuring tape
Hand level	
Light accessories and equipment	
Coupled rubber hose	Shackle
Sling (wire-rope)	

TASK 7 EXCAVATE TRENCHES AND INSTALL UTILITIES	
Raw materials	
Diesel fuel	Hydraulic oil
Essence	Windshield wiper fluid
Grease	Gear lubricant
Oil (diesel engine)	Grinding wheels
Oil (gasoline engine)	Window cleaner
Gear oil	Chemical extinguisher check
Small tools and accessories	
Flexible hose	Narrow shovel
Surveying chain	Grease gun
Sling (wire-rope)	
Safety equipment and accessories	
Safety boots	Safety glasses
Hard hat	Hearing protector
Fire extinguisher (ABC type)	First aid kit
Gloves	Road safety vest
TASK 8 DO FINISH WORK	
Accessories	
Buckets (V-shaped, ditch and toothed)	Hydraulic jackhammer (rarely)
Construction devices, machines and engines	
Rotary laser	Rotary laser receiver
Electronic ranger limiter	
Tools and instruments	
Adjustable wrench	Tripod level
Sockets	Square shovel
Marker	Measuring tape
Sledge hammer	

TASK 8 DO FINISH WORK	
Raw materials	
Diesel fuel	Hydraulic oil
Absorbent paper towel	Windshield wiper fluid
Workshop paper towel	Hand cleaner
Grease	Window cleaner
Oil (diesel engine)	Chemical extinguisher check
Small tools and accessories	
Nuts	Narrow shovel
Sledge hammer	Grease gun
Safety equipment and accessories	
Safety boots	Safety glasses
Hard hat	First aid kit
Fire extinguisher (ABC type)	Road safety vest
Gloves	

Grid of Occupational Health and Safety Elements

Produced by: **Pierre Abran**, Prevention Consultant
ASP Construction

Table A.2 Description of Hazards in the Shovel Operator Trade

No.	Hazards	Effects on Health and Safety	Means of Prevention
1	<p>Safety hazards or dangers</p> <p>Same-level falls</p> <p>Falls from height</p> <p>Hitting something inside the cab</p> <p>Shovel overturning</p>	<ul style="list-style-type: none"> • Collisions • Contusions • Fractures • Bruises • Sprains <ul style="list-style-type: none"> • Collisions • Contusions • Fractures • Bruises • Sprains <ul style="list-style-type: none"> • Contusions • Bruises <ul style="list-style-type: none"> • Contusions • Fractures • Bruises • Drowning • Serious injuries 	<ul style="list-style-type: none"> • Wear safety boots. • Be more vigilant when moving around the shovel (unequal, muddy, frozen ground). <ul style="list-style-type: none"> • Climb and descend facing the equipment. • Use handles and step plates. • Clean the step plates. • Have the hands free (three support point). <ul style="list-style-type: none"> • Use the safety belt. • Be doubly cautious when using oversized accessories or extended booms. <ul style="list-style-type: none"> • Make sure the ground is stable. • Install stabilization material. • Avoid placing the shovel parallel to the slope. • Observe the maximum degree of slope allowed by the manufacturer. • Observe the shovel's lifting capacity. • Be doubly cautious in bad weather conditions. • Tie the shovel to a barge. • Wear a floater vest. • To avoid soil segregation, be doubly cautious when working on a coffer dam.

No.	Hazards	Effects on Health and Safety	Means of Prevention
	<p>Collision with vehicles</p> <p>Hitting someone who is near the shovel</p> <p>Rock fall (burial)</p>	<ul style="list-style-type: none"> • Serious injuries • Psychological effects • Contusions • Fractures • Bruises • Drowning • Serious injuries 	<ul style="list-style-type: none"> • Wear an orange safety vest with reflective stripes • Pay special attention to vehicle movements. • Make sure no one is near the shovel before performing any manoeuvre. • Delimit a work area, if possible. • Stop any manoeuvre if someone approaches the shovel. • Make sure the ground is stable. • Install stabilization material. • Avoid placing the shovel parallel to the slope. • Observe the maximum degree of slope allowed by the manufacturer.
2	<p>Physical hazards or dangers</p> <p>Exposure to noise</p> <p>Vibrations</p> <p>Electric lines</p>	<ul style="list-style-type: none"> • Deafness • Musculoskeletal lesions • Burns • Electrification • Electrocutation 	<ul style="list-style-type: none"> • Keep the door and windows closed. • Wear hearing protection complying with the Safety Code for the construction industry (SC). • Use anti-vibration devices. • Maintenance the shovel regularly. <p><u>Overhead electric lines</u></p> <ul style="list-style-type: none"> • Observe approach distances from electric lines (e.g.: 3 m for voltages less than 125,000 V). • Use an electronic range limiter. <p><u>Underground electric lines</u></p> <ul style="list-style-type: none"> • Consult Info-Excavation. • Observe the marking and, if necessary, have it redone. • Dig 1 m from the marking. • Work in collaboration with a flagger.

No.	Hazards	Effects on Health and Safety	Means of Prevention
3	<p>Chemical hazards or dangers</p> <p>Foreign bodies in the eyes (dust, debris particles)</p> <p>Exposure to smoke and fumes</p> <p>Expose to contaminated materials</p>	<ul style="list-style-type: none"> • Eye injuries • Blindness (chemicals such as acid) • Respiratory problems • Intoxication • Asphyxia • Respiratory problems • Headache • Nausea • Vomiting • Loss of consciousness 	<ul style="list-style-type: none"> • Keep the door and windows closed. • Wear eye protectors complying with the Safety Code for the construction industry (SC). • Observe the concentrations allowed for contaminants. • Apply a preventive maintenance program for exhaust fumes. • Wear a respirator complying with the Safety Code for the construction industry (SC). • Turn off the engine when the shovel is not being used. • For underground construction sites or tunnels, in addition to the above instructions: <ul style="list-style-type: none"> – make sure to have sufficient ventilation to maintain breathable air quality. • Keep the door and windows closed. • Wear a respirator complying with the Safety Code for the construction industry (SC).
4	<p>Ergonomic hazards or dangers</p> <p>Sitting posture for long periods</p>	<ul style="list-style-type: none"> • Backache • Sciatic nerve problem • Musculoskeletal lesions 	<ul style="list-style-type: none"> • Adjust the operator's seat adequately: <ul style="list-style-type: none"> – lumbar support; – thigh-knee angle of 110 to 120°; – thigh horizontal and feet aligned with the legs. • Have a support for the forearm handling the lever. • Prefer an ergonomic cab when choosing the machine.
5	<p>Hand injuries</p>	<ul style="list-style-type: none"> • Cuts • Fractures • Sprains 	<ul style="list-style-type: none"> • Wear work gloves. • Make sure that hand tools are in good condition.

Comments of the Shovel Operator Professional Subcommittee

At the meeting of the shovel operator professional subcommittee, held on April 27, 2012, the members approved the present occupational analysis report on the shovel operator trade. However, they thought that task 2, “Do excavation work with a hydraulic and mechanical clamshell attachment,” is an integral part of the trade but that demand for this type work is very limited.