A GUIDE TO USING PRODUCTIVITY FACTORS FOR ESTIMATING CONSTRUCTION PROJECTS

By Arthur Nix

ABOUT EWKS

Arthur Nix is a contract trainer for HCSS and founder of EWKS. EWKS is devoted to helping companies maximize the features and usage of HCSS HeavyBid through:

- Comprehensive training
- Custom codebook creation
- Efficient workflow solutions.

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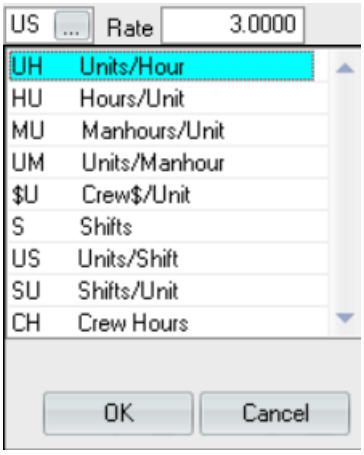
Introduction:

HCSS HeavyBid takes the drudgery out of calculating crew hours by hand, but for the program to be the most useful, the estimator must first understand the basis of the software's calculations. An estimate is basically composed of two groups of costs. The first group is a *cost per unit of measure* of a quantity to be installed. For example, this would be a quantity of concrete (cubic yards) or a length of pipe (linear feet). These costs are not governed by time, only by the cost of the material. The second group is a *cost per unit of time to install*. Since the cost is time based, it must be multiplied by a set amount of time to determine a total cost. Because the resources are usually labor and equipment, HeavyBid requires the time unit to be *hour*s for crew based estimating. A *Productivity* factor is used to calculate the total hours required for each activity.

Why should an estimator input productivity as crew hours instead of simply entering crew hours or shifts? First, the productivity will give the construction field management a basis to measure the actual progress of a crew. Second, inputting just shifts or hours for small quantities will not produce significant cost errors, but guessing a quantity of shifts for large quantities can produce gross errors.

In HeavyBid there are *nine different productivity factors* that can be used to calculate total crew hours and total activity costs. This short course will review how HeavyBid uses each type to calculate crew hours. Practice problems are also included to reinforce how each productivity factor can be used in an estimate.

Understanding productivity factors and rates is a critical requirement to fully utilizing HeavyBid. In the problems below, take the time to fully understand the concepts and purposes behind each calculation.



UH (Units/Hour) – This can be worded "how much of a quantity can be installed by a crew in one hour?" As an example, let's calculate how many feet of guardrail can be placed by a crew in one hour.

The units are feet and the length of time is one hour. Notice that the unit of measure is the nominator and the unit of time is the denominator.

Example Calculation:
Activity Quantity = 10,000 linear feet of guardrail

Productivity = 50 feet per hour. The unit of measure is “feet”. Rate is 50.

No. Crew Hours = 10,000 lf ÷ 50 ft/hr = 200 hours

Assume the crew is working 10 hours per shift the number of shifts can be calculated as:

No. shifts = 200 hours ÷ 10 hours/shift = 20 shifts. The number of shifts is for information purposes only.

Practice problem: *A crew has to excavate 56,000 cubic yards. The productivity of the crew is 250 cubic yards per hour. ① How many hours will be required to complete the excavation? ② If the crew is working 9 hours per shift, how many shifts will be required? (Work area below)*

Answer: Crew Hours =

Shifts =

HU (Hours/Unit) – This is the inverse of UH and can be worded “how many hours does it take a crew to install or remove one unit of material?" It is customary to think of installing one unit of material that

requires many hours as *Hours per Unit*. Please note, if it takes 12 hours to prepare for a major concrete placement (1 each) it is better to word it "12 hours per each" rather than "0.0833 each per hour" especially when another person has to review the estimate. Both of these productivities will yield the same results, but the previous method creates less confusion.

Example Calculation:
Activity Quantity = 12 deck concrete placements
Productivity = 9 hours per each deck (placement)

No. Crew Hours = 12 decks x 9 hours/deck = 108 hours. The unit of measure is "each". Rate is 9 hours per each deck.

Assume the crew is working 10 hours per shift the number of shifts can be calculated

No. shifts = 108 hours ÷ 10 hours/shifts = 10.8 shifts. The number of shifts is for information purposes only to the estimator.

***Practice problem**: A crew has to prepare for a number of traffic moves on a project where lanes have to be shifted. There are 25 traffic moves and each will take 8 hours. ① If the crew is working 8 hours per shift, how many crew hours will be required? ② How many shifts? (Work area below)*

Answer: Crew Hours =

Shifts =

MU (Manhours/Unit) – This is worded "how many hours does it take one man to perform a task defined in a units of something". This unit is referred to as Manhours. *Manhours per Unit* or its inverse Unit per Manhour is the standard of productivity measurement across all types of industries. All labor task costs from shoemaking to car manufacturing can be calculated by this factor. Because of it's popularity, many books and manuals are published with data of Manhours per Unit listed based on historical information. Typically, MU (and UM) are used when the task is labor dependent as opposed to equipment dependent. For example, if 6 carpenters are required on a crew forming a bridge abutment then 12 carpenters could be expected to get twice the production. However, if concrete pipe is being installed underground by a crew of 6 using an excavator, doubling the number of pipe layers but still using one excavator will not double the production.

Example Calculation:
Activity Quantity = 4,500 square feet (sf) of concrete form
Productivity = 0.1667 MH/sf
Crew Number = 6 carpenters

Total Manhours = 4,500 sf x 0.1667 MH/sf = 750 MH [Note: it does not matter what the crew size is. The total Manhours will always be 750 MH]

No. Crew Hours = 750 MH ÷ 6 = 125 hours. Note that this value will be applied to each member of the crew.
Assume the crew is working 8 hours per shift the number of shifts can be calculated

No. shifts = 125 hours ÷ 8 hours/shift = 15.6 shifts. (Again the number of shifts is for information purposes only to the estimator.)

***Practice problem**: When concrete forms are removed there is usually a process called "point and patch" where concrete finishers will repair small portions of the concrete surface. ① If there is 9,000 square feet of surface and the productivity is 0.1 MH/sf what is the total Manhours required? ② If a shift is 10 hours how many crew hours and shifts will be required to finish the total quantity with two finishers? ③ How many shifts are required with three finishers?*

Answer: Manhours = *Crew Hours =*

Shifts =

UM (Units/Manhour) – This is worded "how many units of something does it take one man (1) to perform in one hour). It is the inverse of the productivity factor MU. Manhours per Unit is the more typical unit of measure in terms of keeping historical data, but UM might make more sense to the estimator and reviewer.

Example Calculation:
Activity Quantity = 4,500 square feet (sf) of concrete form
Productivity = 6 sf/MH (which is the same as 0.1667 MH/sf)
Crew Number = 6 carpenters

No. Manhours = 4,500 sf ÷ (6 sf/MH) = 750 MH
No. Crew Hours = 750 MH ÷ 6 = 125 hours
Assume the crew is working 8 hours per shift the number of shifts can be calculated

No. shifts = 125 hours ÷ 8 hours/shift = 15.625 shifts.

***Practice problem**: There is 3,000 linear feet of bridge overhang that has to be formed. The width of the overhang is 35 inches. The productivity is 8 sf/MH. ① How many manhours are required? ② If the crew is composed of 5 carpenters how many crew hours will be required? Note: don't worry if you don't know what bridge overhand is. Just multiply length of overhang by width to get area. This area is for bottom of the overhang only.*

Answer: Manhours =

Crew Hours =

$U (Crew$/Unit) – Based on historical cost data the cost considering labor and equipment costs only might be known. This is not an ideal factor to use since this data can be several years old and inflation has not been factored in. The example below shows that the total hours required is based on the cost of the crew per hour. Experienced professional estimators would typically not use this type of factor.

Example Calculation:
Activity Quantity = 14,000 square yards (SY) of final grading
Productivity = $2.00/SY
The crew cost per hour will be based on the crew setup. This crew composed of a grader, operator and grade checker (labor and equipment) is $120.00/hour

Total Cost = 14,000 SY x $2.00 = $28,000.00

Number Crew Hours = $28,000 ÷ $120.00 = 233.33 hours

Assume the crew is working 9 hours per shift the number of shifts can be calculated

No. shifts = 233.33 hours ÷ 9 hours/sh = 25.93 shifts.

***Practice problem**: An earthmoving operation has an historical cost of $4.00 per cubic yard. ① If there are 55,000 cubic yards and the crew costs are $350/hour how many crew hours will this operation require?*

Answer: Crew Hours =

S (SHIFTS) – This option is really not a productivity factor since units have to be assumed. Where are the units? The estimator with experience on the activity knows how many shifts will be required, so the units (while not shown) are still in the knowledge base of the estimator. HeavyBid takes the Shifts and converts them to hours and calculates the total number of hours of the crew. Typically, the Shifts' function is used for small quantities, because due to setup/takedown time it is simply better to assume a set number of shifts. It is not recommended for large quantities as it does not reveal how the estimator derived the number of shifts to anyone reviewing the estimate. An overuse of this factor usually reveals that the estimator lacks formal estimating training.

Example Calculation:
Activity Quantity = 20 linear feet of sidewalk to be installed

Assumed number of shifts = 1 each

Number of hours/shifts must be known. For the example, the shift is 10 hours.

No. Crew Hours = 1 shift x 10 hours/shift = 10 hours

***Practice problem**: An estimator assumes that 5,000 sf of formwork will require 12 shifts. ① If the crew size is 6 and the shifts are 10 hours each determine the Manhours per square foot. (Work area below*)

Answer: Manhours per Square Foot (MU) =

US (Units/Shift) – This can be worded "how much of a quantity can be installed by a crew in one shift". An example is calculating how many cubic yards of concrete can be placed by a crew per shift. The units are feet and the length of time is one shift. Now a shift can also be one day, but if a day is broken into more than one shift then this will not be accurate.

Example Calculation:
Activity Quantity = 10,000 linear feet of pile to be driven
Productivity = 500 feet per shift

No. Crew Hours = 10,000 ft ÷ 500 ft/shift = 20 shifts

Assume the crew is working 10 hours per shift the number of crew hours can be calculated

No. Hours = 20 shifts x 10 hours/shift = 200 hours. Only the 200 hours is actually used to calculate labor and equipment costs for the activity but the shifts were used to get to this number.

***Practice problem**: A crew has to excavate 65,000 cubic yards. The productivity of the crew is 2,500 cubic yards/shift. ① How many shifts will be required to complete the excavation? ②If the crew is working 9 hours per shift, how many crew hours will be required (Work area below).*

Answer: Crew Hours =

Shifts =

SU (Shift/Unit) – This is the inverse of US and can be worded "how many shifts does it take a crew to install or remove one unit of material?" When would this be used instead of a productivity factor of US? It is usually more practical to think of installing one unit of material that requires many shifts as Shifts per Unit. If it takes two shifts to prepare for a major concrete placement it might be more logical to word it "2 shifts/each" rather than "0.5 units/shift" but it means the same thing.

Example Calculation:
Activity Quantity = Install 12 each 24 foot deep manhole which takes 3 shifts per each.

Productivity = 3 shifts per each

No. Shifts = 12 each x 3 shifts/each = 36 shifts. Assume 10 hours per shift

No. Crew Hours = 36 shifts x 10 hr/shifts = 360 hours

***Practice problem**: A crew has to prepare for a number of traffic moves on a project where lanes have to be shifted. There are 25 traffic moves and each will take 2.5 shifts. ① How many shifts will be required? ② How many crew hours will be required if the crew is working 9 hours per shift? (Work area below)*

Answer: Crew Hours =

Shifts =

CH (CREW HOURS) – Like "Shifts" this option is really not a productivity factor as it has no units involved. The estimator with experience on the activity knows how many crew hours will be required for the job, so really the units (while not shown) are still in the knowledge base of the estimator. since this factor uses crew hours to calculate the crew's labor and equipment costs, HeavyBid does not have to make any extra calculations. Like Shifts, it is not recommended as a productivity. UM and UH are far superior choices.

There is no need for an example as crew hours does not involve any calculations.

CONCLUSION: Understanding productivity and how crew costs are calculated are critical for producing accurate estimates. Successful construction companies manage projects by monitoring productivity along with costs. A complex project can only be estimated by breaking it down to smaller tasks where a productivity value can be applied. With this basic understanding of how to calculate productivity costs, estimating with the HeavyBid software will be easier and more efficient.

Answer Key: Please email me at anix@ewksol.com to receive the answer key. (I want to get your feedback and answer any questions you may have about the course or the field of estimating)

Arthur Nix is a contract trainer for HCSS HeavyBid and an industry leader in estimating software. His firm, EWKS LLC, is devoted to developing workflow solutions to maximize the features and usage of HeavyBid. For more information on services offered email him at anix@ewksol.com or got to www.ewksol.com for more information. Any comments or suggestions on this course would be greatly appreciated. Email us for the answer sheet to this course.