Recommended method for determining production costs (for 1 more and many more)

Overview of goal and method for cost estimation:
Cost estimation is very difficult to do accurately, but it is very important for us to understand the relative impact of design and production decisions on overall cost and manufacturability. To this end, we recommend reporting both your estimate of the total number and duration of manufacturing and assembly operations, and your estimate of the total production costs.

The recommended process for production cost estimation is to sum the purchased materials and components cost with an additional cost based on labor cost but modified to account for overhead, equipment cost (based on the level of worker skill required), and tolerance levels specified. **Note that the labor cost is based on total production time which includes**

1. setup,
2. the actual manufacturing or assembly operation,
3. inspection to verify compliance with dimensions and tolerances,
4. any performance testing that would be expected for each unit,
5. cleanup, and
6. packaging (if applicable).

Purchased materials and components:
- For production of 1 or a few products: Use actual prices paid for purchased items, and price that would have been paid for donated items (nothing is free in the actual costing of a product).
- For larger production runs (1000 or more at a time), use quoted price for lots of 1000 from the selected vendor, or use the actual purchase price for small quantities less a 15% bulk purchase discount.

Labor, Overhead and Equipment Costs:

Labor/overhead/equipment cost =

(total time to complete operation(s) in hours) x (labor rate for the operation) x

[1 + (basic overhead factor) + (Equipment factor) + (Special operation/tolerance factor)]

- **total time to complete operation(s):** remember to include setup, the actual manufacturing or assembly operation, inspection and testing to verify compliance with dimensions and tolerances and specifications, cleanup, and packaging (if applicable).
- **labor rate for the operation:** hourly rate based on information about Columbus OH averages for different job classifications available from the US Department of Labor (http://stats.bls.gov/ncs/home.htm, May 2010):
  - **Production occupations**
    - $13.38 for inspectors, testers, sorters, samplers, and weighers
    - $17.72 for miscellaneous assemblers and fabricators
    - $20.18 for specialized skills (CNC programming, CAD/CAM work, non-standard manufacturing operations)
- **Basic overhead factor:** 100% (or a value of 1) is recommended for basic overhead (worker benefits, buildings, utilities, maintenance,...)
• **Equipment factor:** 50% (or a value of 0.5) is recommended for assembly and manufacturing operations that require equipment or tooling (to cover amortized costs, consumables, service,...)

• **Special operation / tolerance factor:** 25% (or a value of 0.25) is recommended for special case operations (laser welding, CNC machining) and / or tight tolerance requirements (due to increased cost of equipment and personnel, levels of scrap and inspection time)

**Cost estimation tables:**
A good way to organize/present this information is with a table that contains the details for the cost equation broken down by component / subassembly / assembly and operation type:

- **component / subassembly / assembly:** indicate if costing is being done for one-at-a-time production or for assembly-line style production.
- **operation(s):** lump as many similar operations together as possible rather than listing each individually. [Example: Cut 1’x1’ bar stock to length per dwg # XXX and make bends on bender per dwg # XXX]

**Example: Cost details for frame subassembly (for one day of assembly-line production)**

<table>
<thead>
<tr>
<th></th>
<th>Operation 1</th>
<th>Operation 2</th>
<th>Operation 3</th>
<th>Operation 4</th>
<th>purchased materials &amp; components cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cut bar stock to length and prep for welding per dwg # XXX and make bends on bender per dwg # XXX</td>
<td>Place cut pieces in jigs for the welder and remove the welded frame from the jigs</td>
<td>Tack and finish welding of prepared pieces in the jigs for subassy dwg # XXX</td>
<td>Inspection, cleanup, etc. for the 8 hour shift</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. total time to complete operation(s) in hours</td>
<td>3 hour per frame</td>
<td>1 hour per frame</td>
<td>1 hour per frame</td>
<td>0.5 hour per frame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. labor rate for the operation</td>
<td>$17.72/hr</td>
<td>$17.72/hr</td>
<td>$20.18/hr</td>
<td>$13.38/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Labor cost = axb</td>
<td>$53.16</td>
<td>$17.72</td>
<td>$20.18</td>
<td>$6.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. basic overhead factor</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Equipment factor</td>
<td>.5</td>
<td>.5</td>
<td>.5</td>
<td>.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Special operation/tolerance factor</td>
<td>.25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. labor/eqpt cost = c x (1+d+e+f)</td>
<td>$146.19</td>
<td>$44.30</td>
<td>$50.45</td>
<td>$16.73</td>
<td>$100</td>
<td>$357.67</td>
</tr>
</tbody>
</table>

Frame production cost estimate

\[= \Sigma (\text{labor/overhead/equipment costs}) + \text{purchased materials/components cost}\]

\[= \$53.16(1+1+0.5+0.25)+17.72(1+1+0.5)+20.18(1+1+0.5)+6.69(1+1+0.5) + \$100\]

\[= \$257.67 + \$100\]

\[= \$357.67\]