AIMCO

Guide to
Productivity Ergonomics Reliability Quality
(PERQ)

Achieving Assembly Excellence

Rev, 03.2016

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WHAT MAKES A TOOL THE BEST?

Being the best tool overall doesn't necessarily mean that every aspect of the tool is better than the competition.

Consider many industries that conduct product comparisons - in a recent study of economy cars, the Nissan Sentra came out on top overall, however, the Sentra ranked third in transmission and steering performance and fifth in suspension performance.

The same holds true with tools. When comparing one tool to another, the size, weight, speed, repeatability, features and benefits, maintenance as well as economic considerations come in to play. Being best overall doesn't mean that EVERY element about the tool is the best, it simply means that, overall, one tools comes out ahead for a particular application.

In addition to the above mentioned comparison criteria, there is also the "big picture" to consider:

- The tool is lighter, but what is it's repeatability performance?
- What is the life cycle cost?
- Will the tool meet the standards for the targeted production rate?

When applying a tool to an application, a solid understanding of what is important to the user and as well as what PERQ elements are critical to the application.

Productivity -	Is the tool fast enough? Will it meet the production rate requirements?
Ergonomics -	Is weight of the tool appropriate for the application? What kind of reaction is produced? Balance?
Reliability -	What are the maintenance requirements? What is the expected life of the tool?
Quality -	What are the life-cycle costs? Is it robust enough for the application? Will it perform at a high level? Will it exceed the required specifications for the application?

CHOOSING THE BEST TOOL

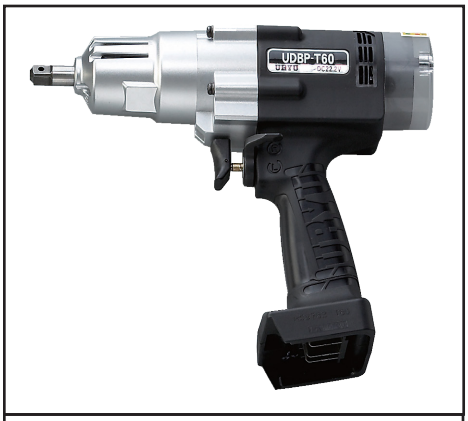
Using AIMCO's trademarked PERQ process guarantees that we will fully understand what's important to the user. After applying the PERQ process, the users priorities within PERQ will be realized. It's possible that the priorities of the user are not necessarily P-E-R-Q but could be E-P-R-Q, or any combination of the four PERQ elements.

AIMCO's extensive product line provides us the ability to choose the BEST tool for the application.

PERQ can be a great tool to refocus the customer on what is truly most important to them. If the customer initially describes their priorities as EPRQ and the explains that they are leaning toward a tool with a shorter maintenance cycle, it would be prudent to remind them that initially ergonomics was their priority and determine if that has changed since the initial evaluation. If so, going to back to the PERQ process and reestablishing priorities will ensure that the tool sold is the right tool for the application.

CHOOSING THE RIGHT DRIVE TYPE

First you need to understand the difference between Continuous and Discontinuous tools.



UDBP Pulse Cordless Tools

Discontinuous-drive tools deliver power in short bursts with no torque between each burst. Common discontinuous-drive tools are pulse tools and impact wrenches.

Continuous-drive tools deliver power continuously without interruptions. Common continuous-drive clutches are automatic shut-off, direct drive or stall, and cushion. Continuous-drive tools are typically gear-driven, and they may or may not have torque control or an automatic shut-off function.

So, which drive type is better? It depends. One factor to consider is whether the joint is "hard" or "soft." A joint is considered hard if it takes less than 30 degrees of rotation to go from snug to final torque. A soft joint requires more than 720 degrees, or two full revolutions.

If cycle time is important, discontinuous-drive tools can increase productivity with their high free speeds on hard to medium-soft joints with little prevailing torque. As an ergonomic benefit, discontinuous-drive tools produce virtually no torque reaction. Because each burst of power is measured in milliseconds, the operator barely feels it.

Continuous-drive tools may be more appropriate on softer joints and joints with high prevailing torque, because the speed of the tools does not change as much during run-down and under load. However,

as a result of this continuous supply of power, the operator is exposed to the torque reaction for a longer period of time. This trade-off in ergonomics is especially critical when the torque exceeds 40 newton-meters. Continuous drive tools are a good choice when less frequent maintenance is desired.

The two most commonly used tools for assembling critical joints are continuous-drive tools with an automatic shut-off clutch and discontinuous-drive pulse tools.

RANKING PERQ PRIORITIES

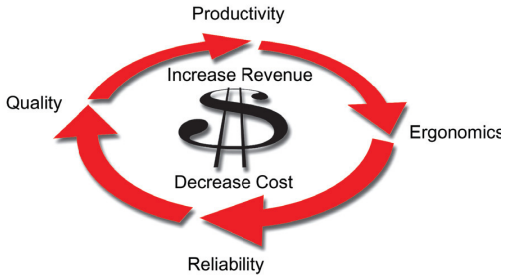
By defining the PERQ priorities we see what is really important to the end user. Understanding that each PERQ element is important, it's knowing which element is most valuable to the end user that ensures that we will select the best tool for the application.

P - Productivity

E - Ergonomics

R - Reliability

Q - Quality



Suppose you ask the user which two components of PERQ are the most important to them, based on their feedback, the tool selection will be the tool that matches these to priorities the closest. There may also be a trade-off in the two elements that are less important to the user.

The following is an example of applying the PERQ principles to applications where both discontinuous and continuous type tools could be seriously considered:

Productivity and Ergonomics -

Productivity and Ergonomics are the users two primary areas of concern with lesser value placed on Reliability and Quality.

Tool Choice - Non Shut-Off pulse tools over angle nutrunners.

High Priorities

P - Pulse tools are faster on hard and medium joints and provide one hand operation.

E - Choose a pulse tool towards the higher end of the tool for size and weight with no torque reaction. Non shut-off tools are lighter than shut-off tools.

Trade Offs

R - Comfortable with fluid changes.

Q - Comfortable with non shut-off tools and operator influence.

RANKING PERQ PRIORITIES (CONTINUED)

Productivity and Quality -
In the instance that Productivity and Quality are the users two main concerns with lesser value placed on Reliability and Ergonomics.

Tool Choice - Shut-off, small to mid-sized pulse tools over nutrunners.

High Priorities

P - Pulse tools are faster on hard and medium joints and provide one hand operation. Small to mid-size pulse tools may be better suited due to the fact that they are lighter tools providing increased productivity.

Q - Recommend shut-off tools to eliminate operator influence, or consider controlled pulse tools if documentation, or process verification, is desired.

Trade Offs

R - Comfortable with fluid changes.

E - Shut-off pulse tools are slightly heavier than non shut-off pulse tools, however, they are still lighter than nutrunners and have no torque reaction.

Productivity and Reliability -
In the instance that Productivity and Reliability are the users two main concerns with lesser value placed on Ergonomics and Quality.

Tool Choice - Non-shut off larger pulse tools on hard or medium joints over angle nutrunners or small pulse tools.

Tool Choice - Angle nutrunners on soft joints over pulse tools.

High Priorities

P - Pulse tools are faster on hard and medium joints and provide one hand operation.

R - Select pulse tools towards the high end of the range or UX over Alpha for longer periods between fluid changes.

Trade Offs

E - Slightly higher weight of larger pulse tools is acceptable and have no torque reaction.

Q - Comfortable with non shut-off tools and operator influence.

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RANKING PERQ PRIORITIES (CONTINUED)

Ergonomics and Reliability -
In the instance that Ergonomics and Reliability are the users two main concerns with lesser value placed on Productivity and Quality.

Tool Choice - Non-shut off larger pulse tools or angle nutrunners depending on torque and joint.

High Priorities	Trade Offs
E - Larger pulse tools are still ergonomic compared to many nutrunners. For nutrunners, the UANs have less torque reaction compared to other brands. **R -** Less frequent maintenance.	**P -** Nutrunner operates at slower speeds. **Q -** Comfortable with non shut-off pulse tools. Having shut-off on angle nutrunners is a side benefit.

Ergonomics and Quality -
In the instance that Ergonomics and Quality are the users two main concerns with lesser value placed on Productivity and Reliability.

Tool Choice - Shut off pulse tools over nutrunners even on softer joints.

High Priorities	Trade Offs
E - Select pulse tools toward the low end of the range for weight. No torque reaction. For decreased weight, choose a larger pulse tool for softer joints. **Q -** Choose shut-off tools for less operator influence or consider controlled pulse tools if documentation or process verification is desired.	**P -** Pulse tools are lower on softer joints. **R -** Comfortable with pulse tools having higher maintenance with softer joints.

RANKING PERQ PRIORITIES (CONTINUED)

Quality and Reliability -
In the instance that Quality and Reliability are the users two main concerns with lesser value placed on Productivity and Ergonomics.

Tool Choice - Angle nutrunners depending on torque and joint.

High Priorities	Trade Offs
Q - Angle nutrunners have a shut-off clutch, which is very repeatable. Consider controlled air or DC nutrunners if documentation or process verification are desired.	**P -** Nutrunner operates at slower speeds.
R - Less frequent maintenance and less frequent fluid changes.	**E -** Comfortable with the heavier weight of nutrunners over pulse tools. Some torque reaction is also acceptable. Shut-off pulse tools are slightly heavier than non shut-off pulse tools.

Joint Characteristics

Hard Joint

"A" Joint
- < 30° rotation from snug to tight
- Metal to metal slam
- No compression

Tool Selection
Care about torque or critical joint?
- Shut-off clutch - air or electric, slower but accurate
- Pulse tool - fast and accurate

Not worried about torque or non-critical joint?
- Impact wrench
- Cushion clutch
- Slip clutch (electric)

General Nuances
- Avoid Stall tools
- Pick high end of tool
- Be careful not to overshoot target torque
- A Pulse tool is better than a nutrunner for hard joints.

Medium - Hard Joint

"B" joint
- About 180° rotation from snug to tight
- Metal to metal with washers or thin gaskets
- Mild compression or part alignment

Tool Selection
Care about torque or critical joint?
- Shut-off clutch - air or electric, slower but accurate
- Pulse tool - fast and accurate

Not worried about torque or non-critical joint?
- Impact wrench
- Cushion clutch
- Slip clutch (electric)

General Nuances
- Avoid Stall tools
- Pick high to mid end of tool
- It's still possible to overshoot target torque
- A Pulse tool is still a better fit than a nutrunner for medium-hard joints.

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JOINT CHARACTERISTICS (CONTINUED)

Medium - Soft Joint

"C" joint
- Approximately 360° rotation from snug to tight
- Metal to metal with lock or Belleville washers
- Medium o-rings or gaskets
- More compression or parts gap alignment

Tool Selection

Care about torque or critical joints?
- Shut-off clutch - air or electric, slower but accurate
- Pulse tool - reasonably fast and accurate

Not worried about torque or non-critical joints?
- Stall tool
- Impact wrench
- Slip clutch (electric)

General Nuances
- Avoid undersized pulse or clutch tools
- Pick lower end of the range of the tool
- Nutrunner may be better than pulse tool
- If pulse tool, use U or UX tools over Alpha tools

Soft Joint

"D" joint
- Over 720° rotation from snug to tight
- Heavy compression of thick gaskets or o-rings
- Wide gap alignment of parts
- Cutting threads into plastic
- Wood screws

Tool Selection

Care about torque or critical joint?
- Shut-off clutch

Not worried about torque or non-critical joints?
- Stall tool
- Impact wrench

General Nuances
- Avoid undersized pulse or clutch tools
- Pick low end of the range of the tool or next model up
- Nutrunner typically better than pulse tool
- If you choose a pulse tool, use a larger U or UX series tool

CONVERSION FACTORS

CONVERSION FACTORS

From↓/To →	Nm	kgf-cm	kgf-m	in-lb	ft-lb	in-oz
Nm	X	10.2	0.102	8.85	0.738	141.6
kgf-cm	0.0980	X	.010	0.868	.0723	13.9
kgf-m	9.81	100	X	86.8	7.23	1390
in-lb	0.113	1.15	0.0115	X	0.082	16
ft-lb	1.36	13.8	.138	12	X	192
in-oz	0.0071	0.072	0.00072	.063	0.0051	X
From↓/To →	psi	MPa	bar			
psi	X	0.0069	0.0689			
MPa	145.0	X	10.0			
bar	14.5	0.100	X			
From↓/To →	in	cm	mm	m	light year	
in	X	2.54	25.4	0.0254	2.70×10^{-18}	
cm	0.394	X	10	0.01	1.06×10^{-18}	
mm	0.0394	0.1	X	0.001	1.06×10^{-19}	
m	39.4	100	1000	X	1.06×10^{-16}	
light year	3.70×10^{17}	9.46×10^{17}	9.46×10^{18}	9.46×10^{15}	X	
From↓/To →	cfm	m^3/min	l/s	From↓/To →	kw	hp
cfm	X	0.0283	0.472	kw	X	.746
m^3/min	35.3	X	16.7	hp	1.34	X
l/s	2.12	0.060	X			
From↓/To →	°F	°C		From↓/To →	dog years	people yrs
°F	X	(°F-32) x 0.55		dog years	X	7
°C	1.80 x °C + 32	X		people years	.143	X
From↓/To →	mph	km/h	mach			
mph	X	1.61	0.00135			
km/h	0.621	X	0.000838			
mach	742	1194	X			

NOTES

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Printed in the U.S.A.
LIT-AC270, Rev 07-18,