Look Alikes . . . These Black & Decker 3/8" power drills bear a close resemblance. But the one on the left is the silver-and-charcoal, heavy-duty professional portable drill. Its consumer-oriented counterpart is on the right. The professional drill is heftier and weighs 4-1/8 pounds compared to the consumer drill's weight of 2-3/4 pounds.

A Primer on Power Tools

What Are the Differences Between Professional and Consumer Tools—and is The Higher Price Justified For On-Site Construction Work

(Editor's Note: Construction Dimensions' interview with Clay Furtaw, Senior Marketing Manager for Black & Decker, is intended to familiarize wall and ceiling contractors with an understanding of professional tools vs. consumer tools, and why, in the long run, the additional cost of a professional tool is often lower than the cheaper price of consumer models.) Furtaw is a graduate mechanical engineer with a masters degree in business administration. He's held various development, project and quality control positions with B&D.)

Q. What are the differences between a consumer tool that is the kind the average do-it-yourselfer would buy and the professional type that a carpenter or a drywall technician would use day in and day out to make a living?

A. The professional power tool is designed to be more powerful, to last longer and to perform better under stressful conditions than its consumer counterpart. For example, on the consumer tool, it's rare that the cord is more than six feet long. That's no major inconvenience because the homeowner doesn't consider it an imposition to hook up an extension cord. He almost expects to have to use one. But the professional grade tool has a cord that's usually a minimum of eight feet long, frequently ten. Why? Because anything less would not permit the user to work at ceiling height without an extension cord.

Q. That seems to make sense. Are there any other differences in cords?

A. Yes, cord materials. For the professional tool cords, we use either natural rubber, or very costly synthetic elastomer jackets which remain flexible in cold weather. The profes-
"The professional power tool is designed to be more powerful, to last longer and to perform better under stressful conditions than its consumer counterpart. It's not that consumers get an inappropriate product but more that a consumer tool is designed so its components are consistent in quality and durability with the intended use of the tool."

Q. Any other difference between cords?
A. Yes. Both tools have, where the tool and the cord join, a bulky area which is called the "cord protector." That guards the cord against bending at a severe angle and possibly damaging the wires inside. On the consumer tool the cord protector is molded right onto the cord. But on the professional heavy-duty tool the cord slips through the cord protector.

Q. What are some other differences between professional tools and those designed for the average homeowner?
A. Okay, then let's talk about switches, and why it costs more to build them for the professional craftsman's tool than it does for the do-it-yourselfer. The primary reasons are dust and switch usage. Let's take the dust issue first. On any job site—especially drywall—you are going to find particles of one kind or another flying around like the residue from drilling into concrete or brick, or drywall, or just plain sawdust.

Even the dirt that the wind picks up around the job site can cause harm. Each one of these is an abrasive that can ruin a switch. So naturally we have to protect the switch mechanism on heavy-duty tools.

The professional is constantly turning the tool on and off all day long, every day he works. That continuous use puts a tremendous amount of stress on the switch.

Q. I guess most people think the motor is the heart of a tool. So what's the difference between a consumer motor and that in a heavy-duty tool?
A. Well, the heavy-duty motor has to handle a much heavier work load, so it has to be designed to generate more power. And it has to be designed not only to withstand, but also to sustain overloading for long periods of time to avoid being burned up. These are a few of the design factors we have to consider.

Q. Okay. So how do you consider them?
A. When we sit down to design a heavy-duty tool, we take three factors into consideration before we even pick up a pencil. The first items of major importance are the ratio of power-to-weight and the actual physical dimensions of the motor. Remember, the professional has to carry this thing around all day, use it over his head, or out at arms' length. We have to make a tool easy for him to use. And here's consideration number two: when we ask a guy to pay $100, maybe $200, for a tool, he's asking us to give him one that's going to last long enough to justify his making that kind of investment. The third point is that the tool is going to face hard use. It's going to be overloaded, overheated, and overworked. We have to anticipate these conditions and build allowances for them into the tool's design.

Q. What are some of the design considerations?
A. One thing is cost. Generally, copper wire costs a lot more than...
There are basically three different types of bearings used in portable power tools, ball bearings, roller bearings and powdered-metal sleeve bearings.

aluminum. Another thing is efficiency. If a length of copper wire and a length of aluminum wire are of the same diameter, at any given voltage more current will flow through the copper. So a motor wound with copper will give you more power than one of comparable size wound with aluminum wire. So we are trading off size and weight in a consumer tool to achieve a device that will cost the consumer less money.

Q. I agree. What are some other differences?

A. Let’s look at the commutators, which are rings of many individual copper bars encircling the armature shaft—literally, the drive-shaft of the motor—at the rear of the armature. Now, in a consumer tool there are 12 of those copper bars. In the heavy-duty tool, there are 24 of them. Also in the consumer tool and professional tool, there are 12 slots in the lamination stack. Because we have twice as many copper bars in the professional tool, we are able to run two—not just one—coils of wire in each of the lamination slots.

Q. But what does all that mean?

A. It means that you get almost none of the arcing, one of the major causes of a motor’s rapidly wearing out.

Q. What about brushes?

A. In both the consumer and the heavy-duty tools, there are two brushes which ride directly opposite one another on the perimeter of the circle of copper commutator bars. They complete a circuit. The electricity from the wall plug passes through one brush, into a commutator bar, through the wire coils, and back out the opposing commutator bar, and into the second brush. And the cycle is repeated, and repeated, and repeated.

Q. Okay, I’m still with you.

A. But we can even further reduce arcing by more precise positioning of the brushes. To do that we use a brass holder that has very tight tolerances for the brushes. This assures a more consistent positioning of the brushes in relationship to the copper bars of the commutator.

Q. So the designer is mainly fighting heat generation?

A. Yes. A heavy-duty tool, as we know, is designed to work harder and more consistently despite more overloading or more heat build-up. One of the ways we compensate for that heat build-up in the professional tool is to use wire with an insulation that resists very high temperatures. Also, in a heavy-duty tool, once the wire is wrapped around the commutator and the armature, we drip resin onto the windings. By capillary action it finds its way into the coils and coats every wire. That resin has the effect of bonding the wires together into a solid unit so that under high temper-
atures, and speeds that go to 25,000 RPM, one wire doesn’t rub against another and short circuit.

**Q. Does that resin also help guard against the dust and grit that you find out on a job site?**

A. It sure does. And in many heavy-duty tools, you’ll find another layer of protection as well.

**Q. Now, what about bearings?**

**What kind do you use in the two different tools?**

A. For the heavy-duty professional tool we use ball bearings for the motor armature. Our consumer tools use some ball bearings, but generally, they use sleeve bearings more extensively. It’s our philosophy that the components be consistent with one another, and with the intended use of the tool.

**Q. What kind of bearing do you use in other parts of the tools?**

A. We’re careful to match the bearing to the job. For example, there are basically three different types of bearings used in portable power tools; ball bearings, roller bearings, and powdered-metal sleeve bearings. In a heavy-duty tool’s spindle we use a ball bearing because it has the ability to withstand the multidirectional forces imposed on it. We normally put a sleeve bearing in the consumer tool because it is not subjected to the forces you find on a construction site. After all, why put a diamond movement in a low-cost watch?

**Q. I guess we’ve pretty much gone through the insides of tools, except for one thing: gears. Tell me the difference, if there is one.**

A. There is and the difference is simple but important. A heavy-duty tool usually has gears of wrought steel which are heat treated after machining. The heat treating hardens and toughens the metal. Now don’t confuse hardness with brittleness. As for consumer tools, we frequently use powdered-metal gears, good but much less expensive.

**Q. Is it true that the spindle is the most expensive item on a drill?**

A. Yes. On a professional tool the jaws—the parts of the chuck that actually grasp the drill bit—are made of very costly steel case—hardened for durability. When you consider the relatively fewer times the spindle is used on a consumer tool, it’s easy to see why we use a heat treated, less expensive variety of steel.

**Q. Is one chuck more precise than the other?**

A. By all means. The “run out” factor is precisely two-to-one. You could call that the wobble factor. In a consumer tool, a wobble of ten one-thousandths (.010) of an inch is accepted, but on a professional tool we do not tolerate variance of more than five one-thousandths (.005) of an inch—only half as much.

**Q. I’ve noticed that a lot of plastics are used in professional tools nowadays. They’ve always been common in consumer tools, but not in heavy-duty equipment?**

A. The plastics used on heavy-duty tools generally cost at least as much, and in many cases more, than comparable metal parts. We are using plastic because it does a better job than metal. It is safer than metal because it is a much better electrical insulator.

**Q. What about assembly? Is there a difference between consumer and professional tools?**

A. Let’s consider that we have three different external parts on a tool—the gear housing, the motor housing, and the handle. One way or
another, they have to be joined into a single unit. We assemble a heavy-duty tool like a Chinese puzzle—everything interlocks.

**Q.** Go on.

A. Where each of these three parts come together in a professional heavy-duty tool, we have pilot pins to set the alignment. Then we have separate sets of screws that join the first to the second, and the second to the third. It’s a rigid and well integrated structure. Drop it, and it’ll stay pretty much in line. Now, on a consumer drill we have just one set of screws that go from the gear case, through the motor housing, into the handle. Well, you can see that there’s a greater possibility of misalignment from the axis there. But it doesn’t make that much difference in a consumer tool which isn’t really subjected to a lot of hard use on a job site... dust and weather extremes, throwing around, banged, dragged and dropped... its cord pulled, swung and twisted.

**Q.** Can you sum up briefly the difference between a consumer tool that’s designed for the weekender who uses it at home, and the tool that a tradesman uses to earn his living?

A. Sure. A heavy-duty tool is built to do one kind of job, and the consumer tool another kind of job. The professional power tool works all day every day often under adverse conditions. The consumer tool is used considerably less frequently, and probably with a lot greater love and tenderness. The professional tool costs more. Both perform their intended functions well, and both are excellent values. But don’t expect a consumer tool to do a professional’s work.