



## **Deep Hole Drilling**

- Machines
- Automation
- Applications

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## **Definition of Deep Hole Drilling**



#### HOLE DEPTH : DIAMETER (D:d)

- 5:1 Common twist drills
- 10:1 High performance twist drills with through-tool coolant
- 20:1 Special deep hole drilling tools with through-tool coolant
- 100:1 Deep hole drilling tools on dedicated deep hole drilling machines

200:1 Gundrilling tools on high performance gundrilling machines

400:1 Extreme drilling range, proprietary processes and equipment required

We use a "Depth to Diameter" ratio to put dimension to deep holes.

Example:

1.00 inch diameter 4 inches deep = 4:1 ratio [not deep]

0.20 inch diameter 4 inches deep = 20:1 ratio [deep hole]

0.04 inch diameter 4 inches deep = 100:1 ratio [very deep hole]

Depth to Diameter Ratio



#### **Gundrilling vs. Deep Hole Drilling**



**Gundrilling** is often used as a catch-all term for deep hole drilling. It is incorrectly applied in many cases.

The word "gundrill" actually refers to one specific type of tool used to drill deep holes.

**Deep Hole Drilling** refers to any process that creates holes with a depth to diameter ratio not normally possible with conventional tools.



#### **Industry Applications for Deep Hole Drilling**



Aerospace



Automotive



Mold



#### **Defense/Firearms**



Oil and Gas





Agriculture/Construction



Job Shop



## Deep Hole Machining (not just drilling)





PUSH- COUNTER BORING/ REAMING 20 - 630 mm [0.79 – 24.8 in] External coolant



TREPANNING

[0.79 – 20.0 in]

External coolant

20 - 500 mm



SKIVING AND ROLLER BURNISHING 20 - 500 mm [0.79 - 20.0 in] External coolant

BOTTOM

FORMING

20 - 500 mm

[0.79 – 20.0 in]

External coolant



BOTTLE BORING Special application External coolant





External coolant





## Can you drill deep holes on a CNC machining center?



Gundrilling on a machining center at UNISIG.

Yes, CNC machining centers can drill deep holes, in certain applications.

- Very productive in certain cases where holes aren't extremely deep and tolerances are forgiving.
- Limitations with very deep holes requiring close tolerances and high process reliability.
- Large diameter holes exceed the power, torque, thrust, coolant flow and chip removal and dimensions of machining centers.





#### How deep can you drill with a deep hole drilling machine?



A UNISIG B-Series machine capable of drilling 40 feet [12 meters] deep

Hole depths are mainly limited by the tooling and equipment available, not the process itself.

- 40ft and longer is possible in larger diameters.
- Depth to diameter ratio is the determining factor.



## What kind of tools are used for deep hole drilling?



Common tools for drilling deep holes from solid.

There is not one universal tool used in deep hole drilling.

There is a wide range of tooling available, each designed for a specific area of application need.

Common examples:

- Solid carbide gundrills
- Brazed gundrills
- Indexable gundrills
- Brazed BTA drills
- Indexable BTA drills



**Primary Deep Hole Drilling Tool Systems** 

# **GUNDRILL**

Internal Coolant Delivery External Chip Exhaust



# BTA

External Coolant Delivery Internal Chip Exhaust





### Gundrill



#### Gundrill

Single flute, self-piloting tool used to drill deep holes.

Coolant is introduced through the tool. Chips are exhausted outside the tool.

Typical hole size range 0.8 - 50 mm [0.03 – 2.0 inch]

Gundrilling tools



#### **BTA Drill**



BTA tools – Boring and Trepanning Association

#### **BTA Drill**

Self-piloting tool for deep hole drilling and machining.

#### BTA stands for "Boring and Trepanning Association." Many tool manufactures produce tools using this concept.

Coolant is introduced around the tool. Chips are exhausted through the center of the tool.

Typical hole size range 13mm – 300mm [0.50 – 12.00 inch]



## Hole quality?

DROCESS	CONFIGURATION	HOLE SIZE	HOLE STRA	AIGHTNESS	SURFACE FINISH		
PROCESS			(inch/foot)	(mm/meter)	µ-inch Ra	µ-m Ra	
Gundrilling	Tool rotate- Work rotate	IT6-IT11 (heavily influenced	0.001-0.004	0.08-0.33		0.2-6.3	
	Tool stationary- Work rotate		0.002-0.006	0.16-0.5	8-248		
	Tool rotate- Work stationary	material)	0.012	1.00			
BTA	Tool rotate – Work rotate		0.001-0.003	0.08-0.25		1.5-3.2	
<ul><li>Solid drilling</li><li>Trepanning</li></ul>	Tool stationary – Work rotate	IT8-IT10	0.003-0.005	0.25-0.42	60-125		
• Counter-boring	Tool rotate – Work stationary		0.012	1.00			
Pull boring	Tool rotate- Work rotate	IT7-IT9	0.001	0.08	32-125	1.5-3.2	
Skive-burnishing	Tool rotate- Work stationary	IT8-IT9	as received	as received	< 8.0	< 0.2	

Each application is different, but in general deep hole drilling tools can be applied in close tolerance applications.

Deep Hole Drilling tools by design produce high quality holes.

- Self-piloting tools burnish the hole as they drill, so roundness, finish and diameter tolerance is very well controlled.
- Hole straightness is superior to other methods, particularly as the hole gets deeper.
- Specialized tooling is available for improving finish and tolerances, such as skiving and roller burnishing.



## **Improving Concentricity**



Tool and workpiece rotation

**1. ROTATING TOOL** - Typically used for non-symmetrical components, or off-center hole requirements

**2. ROTATING WORKPIECE** - Used for round parts with a deep on-center hole, and allows for a reduction in drill drift.

**3. COUNTER-ROTATING TOOL AND WORKPIECE** - Used for round parts with a deep on-center hole, provides the best hole straightness and concentricity.

Three drilling process types

The drilling process type will improve drill drift in concentric holes:

Rotating tool only = poor concentricity

Rotating work only

= better concentricity

Counter-rotating tool and work

= best concentricity



#### Can deep hole drilling be automated?



UNISIG Deep Hole Drilling Automation

Automation in deep hole drilling is very common.

- Increases spindle utilization
- Improves workpiece quality
- Reduces setup and changeover time
- Reduces costs



#### More questions?



#### **unisig.com** - knowledge center, downloads, videos

	le Drilling Methods			Applicatio	Applications and Tolerances			BTA Drill Tube Size and Solid			
and		ADDITIONAL TOOLS FOR USE ON BTA MA	CHINES	APPLICATION	APPLICATION OBJECTIVE		Drill Diameter Standards				
		PUSH- COUNTER	Counterboring enlarges an existing hole that is drilled or cast	Solid drilling	Large stock removal.	BTA	Tube OD	Drilled Hole	Drilled Hole		
	plant is introduced through the machine spindle and tool center	BORING/ REAMING	<ul> <li>Push configuration tools pilot off a finished bore (wear pads supported by finished hole diameter). They can also be designed to pilot off the nee-hore (wear pads supported by pre-hore diameter) for stringent</li> </ul>	Counter-boring/	Large stock removal; may be used for finishing operations	Tube Size	(mm)	Diameter (mm)	Diameter (inch)		
	t be ground in tool tip for form tool operations	20 - 630 mm [0.79 - 24.8 in] External coolant	concentricity requirements	Transping	Large stock removal at lower horsepower; core-slug left	794	11	12.6 - 13.6	0.496 - 0.535		
	Id carbide, and inserted tools are available		Multi-cutter counterbore tools are available for high stock removal     Reaming performs the same operations as counter boring, but typically, a reduced radial depth and unique	Inspanning	after the operation is reusable	795	12	13.6 - 14.6	0.536 - 0.575		
			geometry are used	Pull counter boring	Straighten the hole or achieve uniform wall thickness	796	13	14.6 - 15.6	0.576 - 0.614		
				Skiving	Create a geometrically true round hole	797	14	15.6 - 16.7	0.615 - 0.657		
		PULL BORING 20-620 mm 1079-248 m] Estematicablest TEEPANNING 20-520 mm 1079-200 m]	<ul> <li>A special computation of counterboring, in which the tool enlarges the existing bore as it is pulled back through the workpiece</li> </ul>	Roller burnishing	Create a mirror-surface finish or impart desired surface qualities	798	15	16.7 - 17.7	0.658 - 0.696		
			The boring bar is in tension rather than compression, providing better control over hole straightness	Chine homishing	Increase productivity compared to individual skiving+ burnishing	- 799	16	17.7 - 18.9	0.697 - 0.744		
			-Can be used to straighten a noie with tools designed to follow the center line of the machine by supports     off the finished hole	g skille building	applications Eliminate the metrical stress have left hy machining mesons and	800	17	18.9 - 20.0	0.745 - 0.787		
			Can also be designed for maintaining uniform wall thickness, with tools made to pilot off existing holes.	Honing	control the hole diameter.	- 801	18	20.0 - 21.8	0.788 - 0.858		
~			<ul> <li>A lantern chuck may be used to align a guide bushing to the centerline of the machine</li> </ul>		HOLE STRAIGHTNESS SUBFACE FINISH	802	20	21.8 - 24.1	0.859 - 0.948		
				PROCESS CON	IFIGURATION HOLE SIZE (inclu/foot) (mm/meter) u-inch Ra u-m Ra	804	22	29.1 - 20.9	1049-11039		
			<ul> <li>Process performed on blank material without a pre-drilled hole. The tool leaves a solid core in the middle the hole, rather than removing the entire machined area in the form of chips</li> </ul>	Tool	rotate- IT6/IT11 0.001-0.004 0.08-0.33	805	24	20.4 - 20.7	1120 1220		
v			Consumes less power than solid drilling, for the same hole diameter	Tool	stationary (heavily account of a state of a state	805	20	210-222	1.130 - 1.220		
	+	External coolant	Trepanning in blind hole applications may not be practical due to the difficulty in removing the core	Gundning Wor	krotate / influenced 0.002-0.006 0.16-0.5 8-248 0.2-6.3	807	20	372-363	1212-1415		
•				Wor	k stationary material) 0.012 1.00	- 808	33	36.2 - 39.6	1426 - 1559		
				Tool Wor	rotate - 0.001-0.003 0.08-0.25	809	36	396-430	1560 - 1697		
		POTTOM	Rottom formion is essentially a form tooling operation for finishing off the base of a hole	Solid drilling Tool	stationary - 178-1710 0.003-0.005 0.25-0.42 60-125 1.5-3.2	810	30	430-470	1693 - 1850		
		BUTTOM FORMING 20-500 mm [079-200 in] External coolant	After deep hole drilling, the drawing may require a specific form to the hole	Counter-boring Tool	rotate - 0012 100	811	43	470-517	1851 - 2035		
elant is introduced through of the tool gaid through the tool canter ndiffic, if IA method prover requ and has higher power requ e and indexable tools are av			Bottom forming tools are guided with wear pads along the finished hole diameter, and have very specific     deviants dependence on sustemer needs	Wor	k stationary 0012 100	912	47	517-562	2036 - 2212		
	olant is introduced through the space between the finished hole of the tool		Radius, steps, and flat bottom forms are common	Pull boring Wor	rotate IT7-IT9 0.001 0.08 32-125 1.5-3.2	- 813	51	562-650	2213-2559		
	ged through the tool center and machine spindle			Skive-burnishing Wor	rotate- k stationary IT8-IT9 as received as received < 8.0 < 0.2	813F	56	606-650	2 386 - 2 559		
	ndrilling, BTA method provides higher penetration rates and has higher power requirements			011115750 011165	ar an an an an	814	56	650-670	2559-2637		
	e and indexable tools are available	SKIVING AND ROLLER	<ul> <li>A skiving tool can be visualized as a modified floating reamer, used to finish the surface when close diame</li> </ul>	BI OUDY INC	116 117 118 119 1110 1111	815	62	67.0 - 73.0	2638-2873		
			and roundness tolerances are required	0 3	0.006 0.010 0.014 0.025 0.040 0.060	816	68	73.0 - 80.0	2.874 - 3.149		
		BURNISHING	<ul> <li>Used for rapid stock removal with high penetration rates and low radial engagements</li> <li>A burnishing operation cold works the surface of a workpiece; one or more rollers are pressed against the</li> </ul>	3 6	0.008 0.012 0.018 0.030 0.048 0.075	817	75	80.0 - 87.0	3.150 - 3.424		
		10.79 - 20.0 in1	surface, plasticizing the material's top layer, compressing peaks and filling in valleys	6 10	0.009 0.015 0.022 0.036 0.058 0.090	818	82	87.0 - 100.0	3.425 - 3.936		
		External coolant	<ul> <li>In deep hole applications, skiving knives and burnishing rollers are often combined in a single tool to finis the operation in one pass</li> </ul>	18 30	0.013 0.021 0.033 0.052 0.084 0.130	819	94	100.0 - 112.0	3.937 - 4.408		
				30 50	0.016 0.025 0.039 0.062 0.100 0.160	820	106	112.0 - 124.0	4.409 - 4.881		
		BOTTLE BORING Special application External coolant	Bottle boring is also knows as internal profiling or chamber boring     The bottle bold and also an end of the profile the product of the internal of the profile the profile the profile bold and also be also b	SU 80 80 120	0072 0035 0054 0087 0140 0720	821	118	124.0 - 136.0	4.882 - 5.353		
			The boring tool is extended and resected to produce the internated contour inside the workpiece.     The internal profile is then bigger within the part than at the entry and exit	120 180	0.025 0.040 0.063 0.100 0.160 0.250	822	130	136.0 - 148.0	5.354 - 5.826		
			CNC is used to coordinate multiple axes simultaneously to achieve desired profiles	180 250	0.029 0.046 0.072 0.115 0.185 0.290	823	142	148.0 - 160.0	5.827 - 6.298		
		1 the second sec	<ul> <li>www.www.mg.toos.are typically produced to prome a specific workpace, of series of workpaces</li> </ul>	315 400	0.036 0.057 0.089 0.140 0.230 0.360	824	154	160.0 - 171.9	6.299 - 6.767		
				400 500	0.040 0.063 0.097 0.155 0.250 0.400	825	166	172.0 - 183.9	6.772 - 7.240		
	TEING		The faithing for external laws dimension on the model and even in both the	DIAMETER RANGE	Π6 Π7 Π8 Π9 Π10 Π11	826	178	184.0 - 195.9	7.244 - 7.712		
_	Internal and external coolant	TUBE FINISHING	<ul> <li>This process can be visualized as a push counter boring operation with a gun drilling type (internal) coola</li> </ul>	over incl	tolerance - inches	827	190	196.0 - 207.9	7.717 - 8.185		
	<ul> <li>High-pressure coolant is introduced through the space between the inner and outer tubes.</li> </ul>	COUNTERBORE	supply, and BTA type indexable tooling	0 0.1181	0.0002 0.0004 0.0006 0.0010 0.0016 0.0024	828	202	208.0 - 219.9	8.189 - 8.657		
	Chips are discharged through the inside diameter of the inner tube and	300 - 1200 mm	conterme diameters need extreme amounts of coolant flow, which necessitates a design change in coolant induction and exhaust strategy	0.1181 0.2362	0.0003 0.0005 0.0007 0.0012 0.0019 0.0030	829	214	220.0 - 231.9	8.661 - 9.130		
	exhausted through an adapter mounted to the front of the machining spindle • Typically used to retrofit lathers or machining centers for deep hole drilling	[12.0 - 4 8.0 in]		0.3937 0.7087	0.0004 0.0007 0.0011 0.0017 0.0028 0.0043	830	226	232.0 - 243.9	9.134 - 9.602		
	Chip evacuation is not as efficient as a BTA system, due to smaller area for chips			0.7087 1.1811	0.0005 0.0008 0.0013 0.0020 0.0033 0.0051	831	238	244.0 - 255.9	9.606 - 10.075		
and fluid discharge - Umited displits of dameter ratio compared to IIA system Ejector 10.79 – 7.87 in]	and fluid discharge			1.1811 1.9685	0.0006 0.0010 0.0015 0.0024 0.0039 0.0063	832	250	256.0 - 267.9	10.079 - 10.547		
	- commend to bit system		The tooling application ranges above are generalized and will vary by tooling manufactu	3.1496 4.7244	0.0009 0.0014 0.0021 0.0034 0.0055 0.0087	833	262	268.0 - 279.9	10.551 - 11.020		
	Ejector			4.7244 7.0866	0.0010 0.0016 0.0025 0.0039 0.0063 0.0098	834	274	280.0 - 291.9	11.024 - 11.492		
	200mm 9-787 in]			7.0866 9.8425	0.0011 0.0018 0.0028 0.0045 0.0073 0.0114	835	286	292.0 - 303.9	11.496 - 11.964		
				12.4016 15.7480	0.0014 0.0022 0.0035 0.0055 0.0091 0.0142	836	298	304.0 - 315.9	11.968 - 12.436		
				15.7480 19.6850	0.0016 0.0025 0.0038 0.0061 0.0098 0.0157	837	310	316.0 - 327.9	12.440 - 12.909		

