The Benefits of Electronic pipetting:

How to choose the correct pipettor?

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The Pipette is probably one of the most commonly used pieces of laboratory equipment, but because of this heavy use, concerns over ergonomics have led to the development of more user-friendly, comfortable designs, designed to offset the risk of conditions such as Repetitive Strain Injury.

The following article looks at the positive aspects of electronic pipettes, showing how they can benefit the user, and discusses the principle features to look for when choosing between models.

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There are several electronic pipettors on the market, at least from five different manufacturers. Nowadays every manufacturer emphasises ergonomics, ease of use and less force compared to thumb operated mechanical pipettors. But which electronic pipettor should one choose? This clearly depends on several factors, such as volume(s), type of sample, application, and requirements for accuracy and precision. In most cases an electronic pipettor reduces the workload and improves the accuracy and precision in pipetting work. In the following article, certain criteria are listed that one should consider when choosing an electronic pipettor.

Ergonomics

All manufacturers claim that their pipettors are ergonomical. In principle they all are, but there are clear differences in design, weight and the length, as well as in pipettor stands. In most cases an electronic pipettor is heavier than a mechanical, but on the other hand the diminished workload compensates for the weight. However, the difference (164 g) between the lightest and the heaviest electronic pipettor is more than the weight of the heaviest mechanical pipettor on the market. More important than weight is the fitting of the pipettor to hand (David and Buckle, 1997). Most of the pipettors have a finger support to aim better fitting and balance, but not all. As fitting to hand is subjective, a big-handed user would probably choose a different pipettor than a small-handed one. In addition to fitting, the difference in length can be up to 25%. Usually, the shorter the pipettor, the more ergonomic it is to use. In a laboratory, where space is usually critical, a small handy pipettor and a space-saving carousel stand that holds more than one pipettor is preferable. *Fig. 1* displays certain electronic pipettors and their stands available on the market, and *Table* I lists their features.

Fig. 1: A selection of electronic pipettors available on the market.

Tip Cone Filters

If no protection (filter tips or filter in the pipettor tip cone) is used in pipetting, the pipettor may be contaminated very easily. An economic but effective way to protect both the pipettor and the sample from contamination is to use a filter in the pipettor tip cone (Kolari et al., 1999). With the tip cone filter standard tips can be used in many applications instead of the more expensive filter tips. There is only one manufacturer offering this feature in electronic pipettors is Biohit (*Fig. 2*). In addition, to ensure the safety of the user, forceps for filter placement and removal are packed with each pipettor.

Tip Ejection

Tip ejection demands much force in pipetting. In all electronic pipettors, except for one, the tip ejection is done manually. There are as many different ways to remove the tip as there are manufacturers. The tip ejector button can be located at the front of the handle or tips can be ejected using three fingers on the back of the pipettor. One model has a rotating tip ejector lever, which can be placed on either side of the pipettor. Another one has an extension in the tip ejector located

Fig. 2: The filtered tip cones protect pipettors from contamination and samples from carry-over. Forceps packed with each pipettor enable the easy and clean placement and removal of the filter.

in the front, but adjustable to either side. However, there is one electronic pipettor which features an electronic tip ejector. Only a light touch is needed to eject the tip. Moreover, the design is symmetric and can therefore be used similarly with either the left or right hand. It also enables the easy use of the tip ejector from various pipetting positions.

The tip ejection travel in electronic pipettors varies from a light touch to several centimetres of thumb movement. The needed force varies up to 17-fold (*Fig.3A*). The tip ejection work needed for an electronic pipettor with manual tip ejector varies from 26 mJ to 88 mJ. In comparison, the electronic tip ejection requires only 3,7 mJ work from the user because the rest is done electronically (*Fig. 3B*). Consequently, the actual tip ejection work (mJ) with electronic pipettors can vary even 23-fold depending on the electronic pipettor and model chosen – with mechanical pipettors included the difference can be 100-fold. Thus, when hundreds of tip ejections are done daily, an electronic tip ejector is significantly reduces the risk for Repetitive Strain Syndrome.

Volume Range

There are clear differences in the volume ranges of different electronic pipettors. For example, if 50 µl is to be dispensed, the pipettor of choice can be as follows: 5 to 50 µl, 5 to 100 µl, 10 to 100 µl, 5 to 120 µl or 2 to 125 µl depending on the manufacturer. The same variation is seen with other volume ranges. In general, electronic pipettors offer a wider volume range than mechanical ones. Thus, fewer pipettors are needed to cover a certain volume range and less money needs to be spent.

Ease of Use

The number of programming buttons in electronic pipettors varies from three to seven. Usually, only one button acts as an operating button, but in some models there are two buttons for pipetting actions. The pipettors having fewer buttons with well-designed user interface are often easier to program. Using seven different buttons without reading the manual might not be that easy. The round shape of the handle and the close distance of thebuttons enable the easy one-handed use for all actions from various pipetting orientations.

The positioning of the display varies from the top panel to the front and side. The numbers and symbols are easier to read from top and front panel displays, the front panel offering the best readability during pipetting work. In most electronic pipettors the display is clear but the size and presentation of the numbers and symbols vary. Consequently, pipettors having big, clear numbers are easier to read and use. Some pipettors feature a helpful beep tone, which, however, at some point may be disturbing if it cannot be turned off.

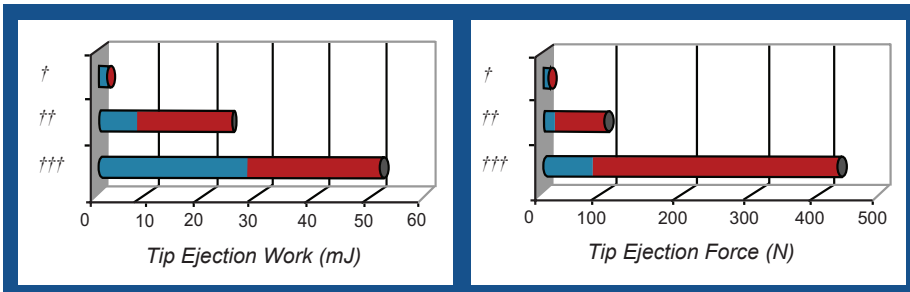
Dispensing and Precision: DC-motor vs. Stepper Motor

In the multiple dispensing function, where an aspirated volume is dispensed in several aliquots, there are differences in precision between various electronic pipettors. This is not only due to the quality of the manufacturing but also due to different hardware, software, material, and design technologies used for the product. The patented DC-motor based technology, using a unique solenoid brake mechanism with integrated optical encoder providing superior displacement precision, has been used successfully over a decade in all Biohit´s electronic pipettors.

Another important feature is the error

	Biohit eLINE	Biohit Proline	Biohit ePET	Rainin edp3	Rainin edp-plus	Labsystems Biocontrol	Matrix impact 2	Eppendorf Research Pro
Weight (g)	174	148	148	167	312	201	210	213
Length (mm)	260	265	265	306	316	272	326	272
Tip ejection	Motorized	4-finger	4-finger	Thumb	Thumb	Thumb	3-finger	Thumb
Tip cone filter	+	+	+	-	-	-	-	-
Integral design	+	+	+	+	- (Tip cone modules)	- (Tip cone modules)	+	+
Direct charging	+	-	+	+	+	-	+	+ (charging prevents use)
Charging stand	+	+	-	+	+	+	-	+
Carousel stand	+	+	+	-	-	-	+	+
Battery	NiMH	NiMH	NiMH	Li-Ion	NiCd	NiCd	NiCd	NiMH
Display	Front	Front	Front	Front	Top	Side	Top	Top
Programming buttons	3	6	6	4	13	4	7	6
Standard programs	11	5 + mixing	3 + mixing	3 + mixing	7	2	5 (needs programming)	13
Manual pipetting mode	+	-	-	+	+	-	-	+
Speed settings	9	5	5	10	10	3	5	10
Overall volume range	0.2-5000 µl	0.2-5000 µl	0.2-5000 µl	0.5-10000 µl	0.5-10000 µl	0.5-10000 µl	0.5-1250 µl	0.5-5000 µl
Inaccuracy at 1000 µl	0.40 %	0.40 %	0.40 %	0.80 %	0.60 %	0.60 %	0.60 %	0.60 %
Imprecision at 1000 µl	0.15 %	0.15 %	0.15 %	0.15 %	0.13 %	0.20 %	0.13 %	0.20 %

Table I: Features of different electronic pipettors available on the market. Note that the length has been measured as the length from the finger support to the end of tip.



† Biohit eLINE Electronic †† Electronic pipettors (Major manufacturers) min/max
††† Mechanical pipettors (Major manufacturers) min/max

Fig. 3: The total force (A.) and work (B.) needed for tip ejection. The first column shows the range of forces/work needed for tip ejection with different single-channel 1,000 µl mechanical pipettors and the second column 1,000 µl/1,250 µl electronic pipettors on the market. Tips have been picked with the same force (30 N~3 kg) to each pipettor and tips recommended by the manufacturer have been used. The total work measured for one tip ejection is equal to the area under the curve ∫F(s)ds, where s is the tip ejection travel and F the tip ejection force.

feedback. in the concept where displacement is microprocessor-controlled with the help of optical feedback sensors, it is guaranteed that the required piston movement has taken place. Should a failure occur, the system will notice it and give an error message. Stepper motor-based pipettors often lack displacement measurement information, which makes the operation unreliable. Moreover, in the worst case, such a pipettor might lose steps during aspiration or dispensing without the user knowing it. Tendency for such a failure is obviously increasing when wearing takes place, for example, if the friction in the piston seal changes out of the specifications.

Charging

In the past, running out of energy during pipetting work was worrying electronic pipettor users. Nowadays electronic pipettors can be easily used for thousands of pipettings without charging the battery. The most advanced electronic pipettors feature both direct charging through an AC-adaptor plus charging through a separate charging stand. The pipettor can be fully charged and used without connecting cables, or used with the AC-adaptor when the battery is empty. The customer can choose whether he wants to have a separate stand or carousel, or just use/charge the pipettor through the more economical AC-adaptor. In some models it is possible to continue pipetting while the pipettor is charged trough the AC-adaptor but there are also models that cannot be operated during charging. With half of the pipettors on the market, charging is possible either through a charging stand or direct charging. The most modern electronic pipettors also have quick charging whereas others demand 12 to 14 hours to ensure a full charge.

Service and Decontamination

Easy disassembling and autoclaving are regarded as important features. In most of the pipettors the lower part (at least the shaft and the tip ejector) is autoclavable, but in some it must be disassembled first and autoclaved as separate parts. To be able to just take off the lower part and autoclave it as whole without changing the O-rings is always an advantage, even if total disassembling is sometimes needed for cleaning.

However, there are also convenient and effective decontamination solutions available on the market, which are used simply by spraying and wiping instead of time- consuming autoclaving (Kolari et al., 1999).

Changing the battery should also be easy and fast, which actually is the case with most electronic pipettors. As environmental aspects are getting increasingly important, the pipettor offering a `green´ NiMH-battery should be a natural choice.

Conclusions

There are several types of electronic air displacement pipettors on the market The best way to find the right tool for each application is to go through the pipetting procedures and find out what pipetting modes/techniques and volumes are needed. The various electronic pipettors offer tens of different programs from simple pipetting to dispensing, cycle counting and user-defined programs. In some pipettors even a manually controlled pipetting mode is available. Speed is also a very important feature, because sometimes a slow speed dispensing one drop at a time is needed and sometimes pipetting should be done really fast. Not many electronic pipettors offer both.

As a summary, before choosing the electronic pipettor it should be tried out. The best decision comes through evaluation and a user´s own experience. However, once you get used to an electronic pipettor, you will find that there will be no going back to mechanicals.

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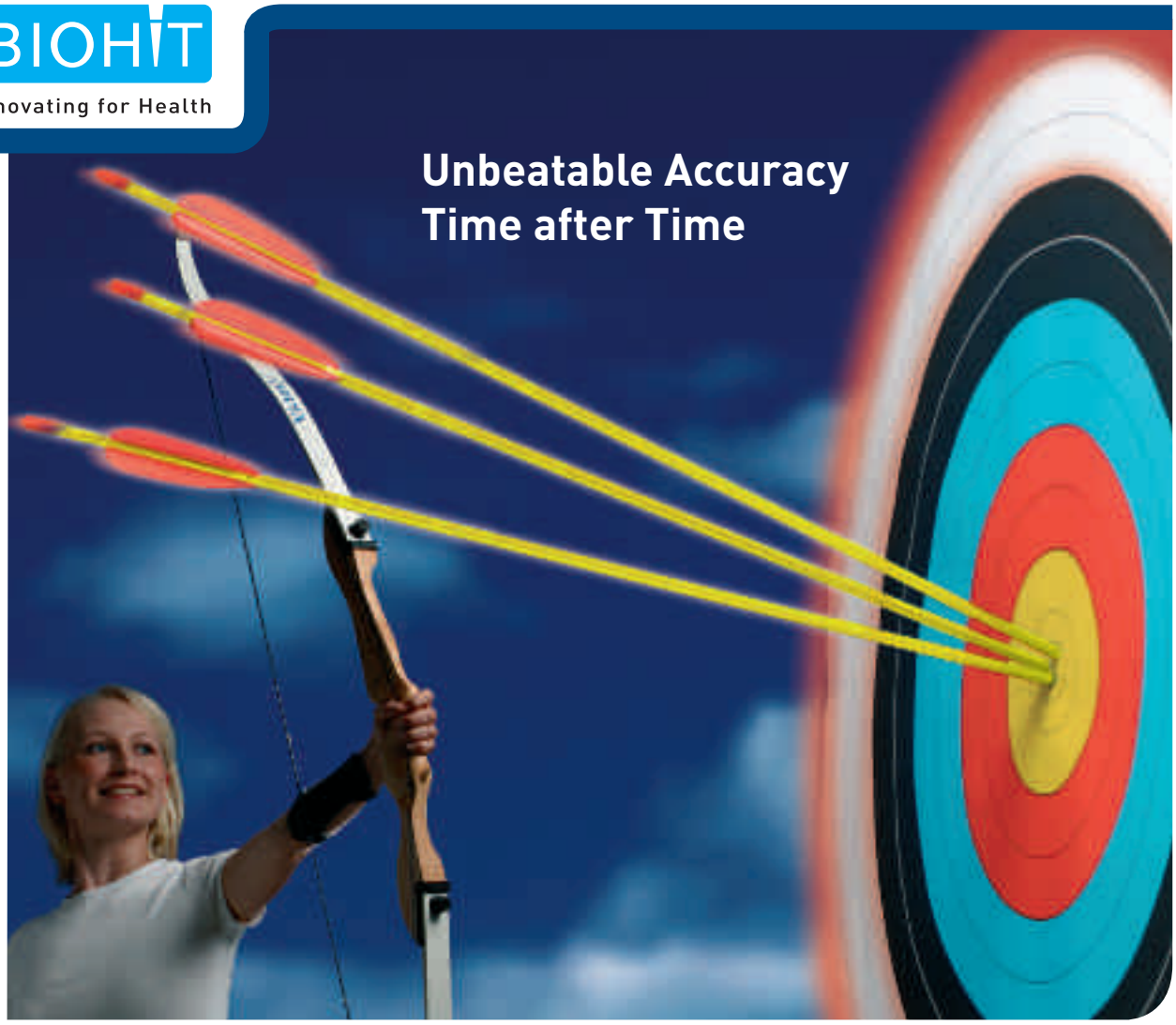

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