HPCC *DATAFILE*

Introducing
the new

HP
Prime

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HP Prime

Bruce Horrocks, #609

HP have launched a new scientific graphing calculator aimed squarely at the high-school and college/university student market.

Its headline grabbing unique feature is a colour, touch sensitive screen that will ensure it gets plenty of attention when it arrives in the shops later this Autumn, for an estimated US$150.

Less obviously, there are a number of clever features that reveal the huge amount of thought that has gone into making the HP Prime better all round.

Let's start with the hardware specifications and then move onto the software and features.

Hardware

Its dimensions are 18 x 8½ x 1½ cm which makes it the same length and width as the 50G but only two-thirds the thickness. At 228g it is a bit lighter than the 250g of a 50G with batteries.

The screen is a 320 x 240 pixel (half-VGA), 16-bit colour TFT affair that is multi- touch sensitive – meaning that more than one finger press can be registered and tracked at a time. However, with the

screen measuring only 9 cm across the diagonal, I suspect that only two fingers can realistically be used. The software divvies-up the screen into 10 lines of 33 characters, plus menu bar and header. It comes with a hard plastic, slide-on cover to protect the screen and the brushed aluminium of the keyboard faceplate.

The processor is a 400MHz ARM; there are 256 Mbytes of Flash RAM for the calculator software and 32 Mbytes of standard memory for user programs.

By now it should be obvious that if the display and processor are taken from a mobile phone and draw the same sort of power, then, inevitably, the battery must also be one taken from a mobile phone. In this case it is a 2200mAh rechargeable Lithium-ion that was also (apparently) recently used on a very popular mobile, so at least spares shouldn't be hard to come by. Re-charging – and powering from mains while in use if so desired – is through a micro-USB cable and a cable and charger are included.

Software

The HP Prime uses the Aplet approach first introduced with the HP 38G and most recently continued with the HP 39gII, although they are now called 'apps'. Pressing the Apps button displays the available apps, dragging your finger up and down the screen scrolls through the available list and tapping an icon launches the app. If you prefer not to get your screen too smeary, the four-way cursor key can be used instead.

The app icons are colour coded: blue for graphing, purple for statistics, orange for solvers and green for explorer apps. Confusingly (although I realise you can't see any colours on this printed page) the Geometry and Spreadsheet apps are coloured red, but no name has been given for the red group.
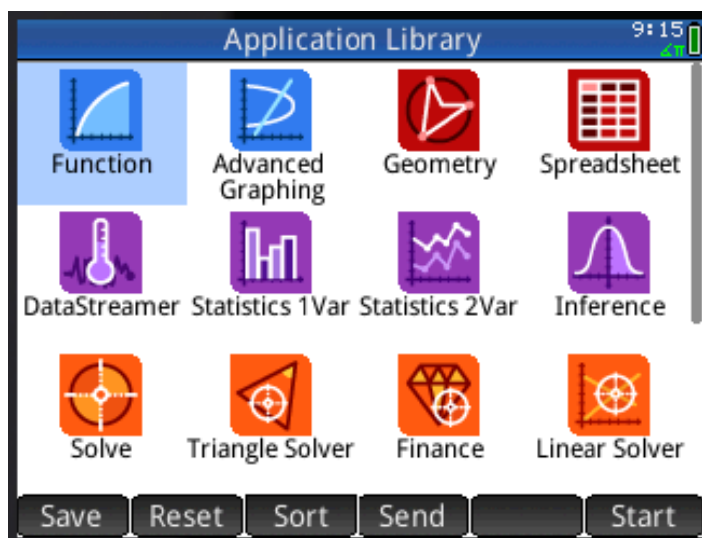
The following table lists the available apps:

Type	App	Explore…
(red)	**(new)** Geometry	Geometric relationships graphically and then find exact solutions using the CAS
Graphing apps (blue)	**(new)** Advanced Graphing	The graphs of inequalities, conic sections, polynomials – virtually any mathematical open sentence in X and Y.
	Function	Real-valued, rectangular functions y in terms of x, e.g.: $y = 2x^2 + 3x + 5$
	Parametric	Parametric relations x and y in terms of t. $$x = \cos(t) \text{ and } y = \sin(t)$$
	Polar	Polar functions r in terms of an angle θ $$r = 2\cos(4\theta)$$
Statistics apps (purple)	Statistics 1Var	One-variable statistical data (x)
	Statistics 2Var	Two variable statistical data (x and y)
	Inference	Confidence intervals and hypothesis test based on the Normal and Students-t distributions.
	Data Streamer	Real-world data captured using a separate kit of sensor probes.
	Sequence	Explore sequences in terms of n or previous values in the sequence.
Solver apps (orange)	Solve	Equations
	Finance	Time Value of Money (TVM) problems and amortization tables.
	Linear Solver	Solutions to sets of two or three linear equations
	Triangle Solver	Find unknown lengths and angles for any triangle
	Spreadsheet **(enhanced)**	Typical spreadsheet but enhanced to allow use with the CAS
Explorer apps (green)		Explore the behaviour of the functions:
	Linear Explorer	$$y = ax + b$$
	Quadratic Explorer	$$y = a(x + h)^2 + v$$
	Trig Explorer	$$y = a\sin(bx + c) + d$$
		when the constants are manipulated

The new Advanced Graphing app significantly improves on the types of expression that can be graphed, versus the HP 39gII, now supporting: conic sections; polynomials in standard or general form; inequalities (not just linear); and functions.

Right is the graph of: $y \text{ Mod } x = 3$

| X: 0.1 | Y: 0.2 | Menu |
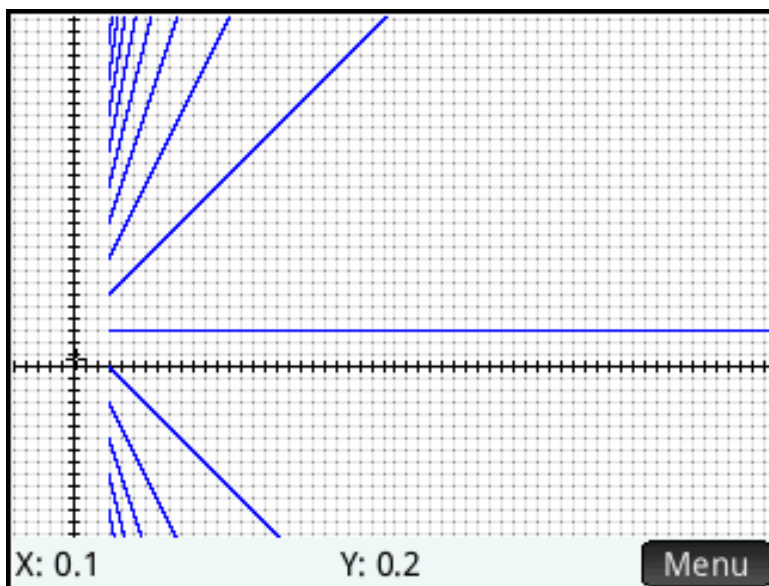
The CAS is now integrated with the spreadsheet app. For example, a sheet containing the values from Pascal's triangle can be easily computed just be applying the nCr (COMB()) function to the row and column values.

	A	B	C	D	E
1	1	Error: Inva	Error: Inva	Error: Inva	Error:
2	1	1	Error: Inva	Error: Inva	Error:
3	1	2	1	Error: Inva	Error:
4	1	3	3	1	Error:
5	1	4	6	4	1
6	1	5	10	10	5
7	1	6	15	20	15
8	1	7	21	35	35
9	1	8	28	56	70
10	1	9	36	84	126
11	1	10	45	120	210

=COMB(Row−1,Col−1)

| Name | CAS | | | Cancel | OK |

Spreadsheet cells do not have to be just numbers. Here we see the binomial expansion of $x + 1$.

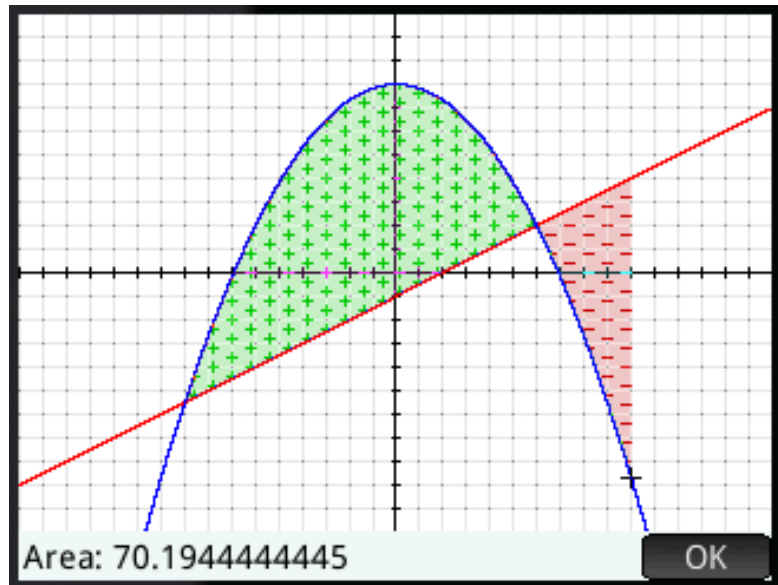|	A	B
1	x+1	
2	$x^2 + 2 \ast x + 1$	
3	$x^3 + 3 \ast x^2 + 3 \ast x + 1$	
4	$x^4 + 4 \ast x^3 + 6 \ast x^2 + 4 \ast x + 1$	
5	$x^5 + 5 \ast x^4 + 10 \ast x^3 + 10 \ast x^2 + 5 \ast x + 1$	

=simplify(expand((x+1)^Row))

| Name | CAS• | | | Cancel | OK |

The touch screen capabilities of the calculator are integrated into these apps:

- in the Spreadsheet app, pinching or un-pinching with two fingers decreases or increases the size of the cells

- in the Advanced Graphing app, the same pinch / un-pinch gesture causes the scale of the graph to change. On the 39gII this can only be done by bringing up the menu, going into the zoom submenu and choosing to zoom; or going out of the graph completely and into the Setup menu. Either way, it disrupts the flow of work – using a touch screen will be much more convenient.

The example to the right shows a graph highlighting the area between a function and a line. I re-created this on the HP 39gII and it quickly becomes a pain to determine the area: the cursor has to be scrolled over to the left by holding down the cursor left button until it is close enough to the intersection that the intersection command will use the left-hand one and not the right-hand one. That done and the value at the intersection obtained, you then have to scroll over to the right and repeat. On the HP Prime, the touch screen at least allows the bulk movement to be done in one go by tapping somewhere near the required intersection and then the cursor or the intersection command used to get the precise value.

Finally, for this section, the HP Prime has its operating software stored in flash memory so new versions can be downloaded from a PC if bugs are found and fixed.

Data entry modes & programming

The HP Prime has RPN, algebraic and 'textbook' entry modes.

RPN mode is restricted to interactive calculations performed in the Home screen. Expressions used in apps etc. are algebraic or textbook.

Programming is in the 'HP Basic' (i.e. not BASIC) language introduced with the HP 38G and steadily built upon in the subsequent models. The HP Prime is no exception and introduces some neat features: for example the user can write a program called 'PLOT', attach it to the Function app and when the Plot button is pressed, the user function is invoked, not the built-in one.

Here is an example program that solves the N Queens problem, that was posted by Tim Wessman in comp.sys.hp48 which gives a flavour of the language:

```
EXPORT NQUEENS()
 BEGIN
   R:=8;
   L1:=MAKELIST(0,X,1,R,1);
   S:=0;
   X:=0;
   REPEAT
     X:=X+1;
     L1(X):=R;
     REPEAT
       S:=S+1;
       Y:=X;
       WHILE Y>1 DO
         Y:=Y-1;
         T:=L1(X)-L1(Y);
         IF T==0 OR X-Y==ABS(T) THEN
           Y:=0;
           L1(X):=L1(X)-1;
           WHILE L1(X)==0 DO
             X:=X-1;
             L1(X):=L1(X)-1;
           END;
         END;
       END;
     UNTIL Y==1 END;
   UNTIL X==R END;
   S;
 END;
```

Clearly, then, a language better suited to writing on a PC and transferring to the calculator rather than writing directly on the calculator. Performance is fast though: the above executes in a fraction of a second. Comments are retained when source is transferred between machines.

Wireless Connectivity

In an interesting move, the HP Prime does not have any sort of wireless connectivity built-in, but it can be added via a plug-in hardware model that connects to the USB port. The module uses an HP proprietary wireless standard, not 802.11 Wifi, and will only work as a slave in a master/slave configuration, the master being a PC running HP's Classroom Manager software.

This allows a teacher to control all the HP Prime calculators in a classroom. A typical example might be a practical lesson collecting statistics such as height and hair colour and, at the end of the lesson, the teacher pushes out a standard set of stats to all students to be analysed as homework.

The wireless modules won't allow an individual HP Prime to communicate directly with another HP Prime, so students have less opportunity to disrupt the lesson, either deliberately or inadvertently.
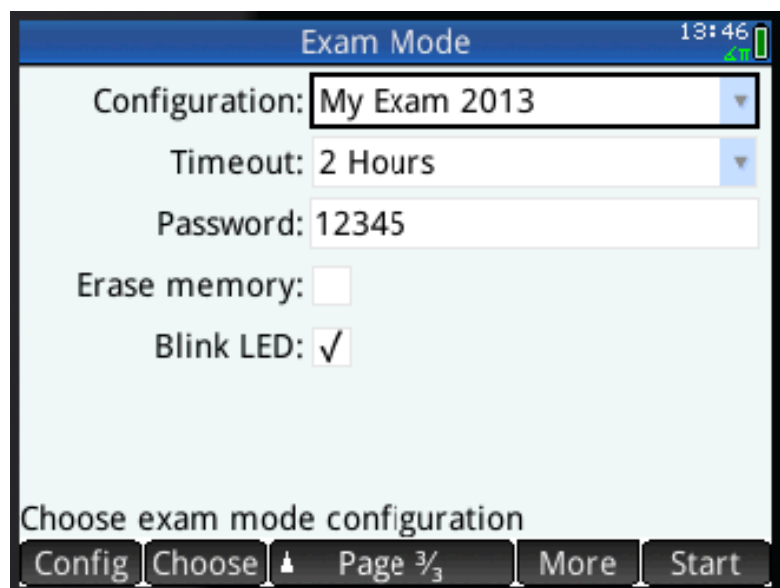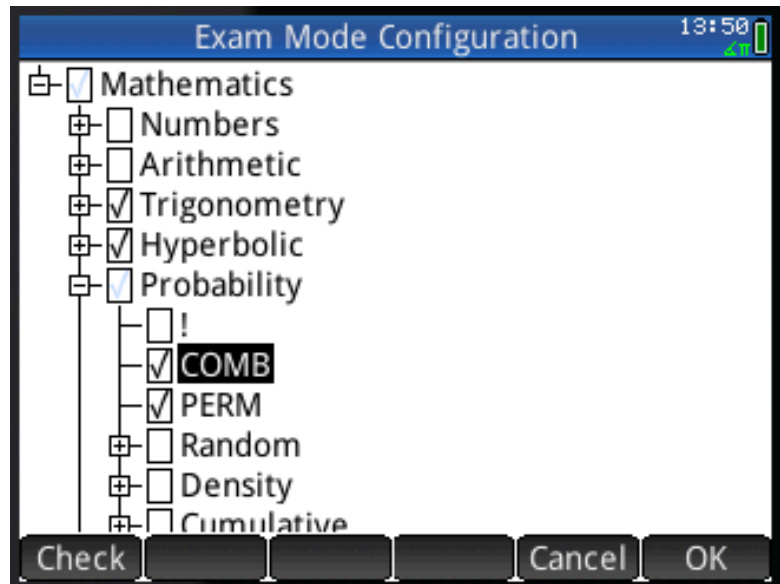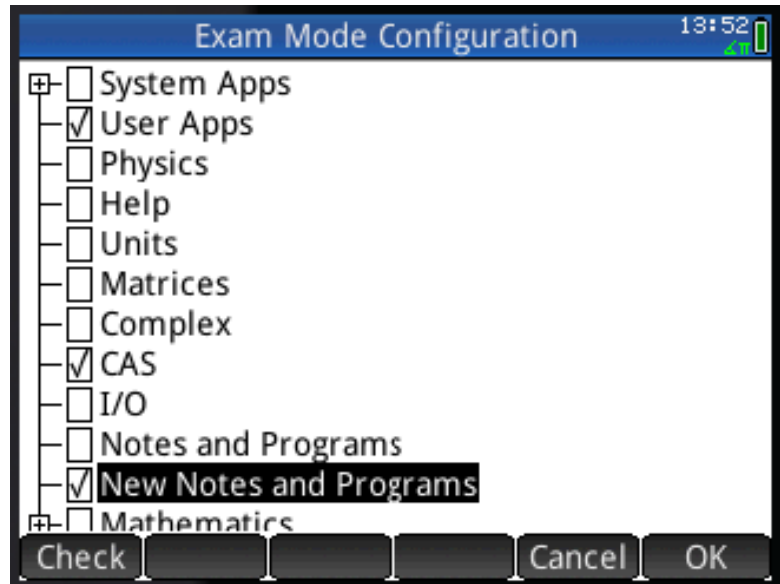
Examination Mode

One final clever feature of the HP Prime is its 'examination mode'. This is an app that allows selected features to be disabled for a period of time. The granularity of what can be disabled is quite flexible. In the example shown to the right, User Apps, the CAS and new notes and programs are disabled (i.e. the student can't write a program in the exam). However, existing notes and programs are allowed and these may be blank or pre-programmed with what the teacher is prepared to accept.

The second example shows that access can be controlled right down to the level of individual commands. I can see this being used in the HHC programming competitions: solve this problem using only tangent and subtraction. :-)

As you can see from the third screen image, the examination mode settings can be saved under different names so different configurations can co-exist. This would allow a teacher to create and distribute a "weekly test" config independently of an "end of term exam" config.

So what's to stop the student simply resetting the calculator? Well, here's the clever bit: when the calculator is in examination mode, three LEDs on the top flash according to a random pattern. However, all calculators

with the same examination restrictions in force will flash with the same pattern, so the teacher or invigilator only has to look for students with no lights, or a different pattern to everyone else to see who is cheating.

Final Thoughts

Examination mode is a nice idea, and one that looks good on paper, but I'm not sure how well it will work in practice. One obvious problem is that the person setting the restrictions needs to test the restricted calculator pretty thoroughly to make sure that the exam is still actually doable in that mode. Another possibility is that a determined cheat will bring in two calculators – one in examination mode and the other loaded with cheat notes and formulas. However, a determined cheat will cheat regardless, so perhaps it is not really a problem.

The lack of regular batteries will annoy some people but I don't see it as an issue. If you are trekking through the Amazon, planning on taking a dozen packs of AAAs to keep your calculator running while away from civilisation for three months then the HP Prime simply isn't the machine for you. Take the 50G instead. Or take a solar-powered external recharger battery designed for mobile phones and recharge as required via USB.

Will the battery run out during an exam, and leave some poor student calculator less? No, is the simple answer, for two reasons. One is that when a calculator can be recharged, it is a simple matter to top it up the night before an exam. With normal batteries you have the dilemma: do I replace a set of batteries which appear to have plenty of life in them, just in case, or take a chance they'll last the exam. And two, if a calculator is critical for an exam, any school worth its salt will have some spares on standby to loan out just in case.

I like the idea of the touch screen – I can already see how some operations will be simplified and as more experience is gained by HP, new ROM versions will only increase and improve the use made of it.

The large user memory – 32Mbytes – is a huge leap forward over the 39gII which only has 256K and was all too easy to fill with statistics data, especially when gathered via the StreamSmart app or after taking a few copies of a stats app. It would be nice to think that the power of the processor, the touch screen, and the speed at which programs run will encourage the development of specialised, bespoke apps for specific industries or companies. However, the availability of cheap Android mobile phones which have all the same benefits plus on-line connectivity may well put paid to that.

An optional RPN mode is a good move to encourage the enthusiasts amongst us. If it were algebraic only, plenty wouldn't give it a second look. But with RPN, some might just come round to the charms of a slim, powerful machine. I know I am.

[Ed: All screen and calculator images courtesy of Hewlett-Packard.]