VW

COLLABORATORS

	TITLE : vw		
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WRITTEN BY		February 12, 2023	

REVISION HISTORY

NUMBER	DATE	DESCRIPTION	NAME

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                                        VWorlds

                    An astronomy/night sky plotting utility

                                Version 2.1

                                By Peter Knight

                                  28/4/96

                                PUBLIC DOMAIN

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1.2   VWorlds.guide/INTRO

```
Introduction
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VWorlds is a utility that allows the generation of pictures of
the night sky from any point on Earth (and indeed from any of the
planets or other objects whose position is calculated by the program).
The main features of the code are,

   * Accurate numerical ephemeris giving planetary/lunar/solar positions
     to a few seconds of arc.

   * Rendering of all major solar system bodies (Sun, Moon,
     planets, selected comets & satellites). The solar system can be viewed
     from a point on any of these objects, not just the Earth.

   * Texture-mapped images of the Earth, Moon and Mars when viewed from
     another body, with shading of night/twilight zones.

   * Scalable projected map of the world showing shaded night/twilight
     zones, position of observer and location of Moon's umbra and penumbra
     during solar eclipses.

   * Maps of Moon and Mars showing longitude of central meridian.

* Orrery, showing positions and orbits of planets and comets from any
  point with respect to the Sun.

* Planetarium view, showing major objects above the horizon.

* Customizable comet database. The position of comets entered
  into the database is calculated and their position displayed.

* Plotting of all stars down to magnitude 7.0 from the SAO catalogue,
  with proper motion information.

* Accurate prediction of 'special events'---solar/lunar eclipse, full/new
  moon, Mercury/Venus conjunction, Mars opposition and lunar occultation.

* Shading of Milky Way region.

* Constellation outlines and names.

* Overlaid annotated grids (horizon, equatorial and ecliptic coordinate
  systems).

* Selectable viewport orientation (horizon, equatorial or ecliptic systems).

* Shading of sky region below horizon.

* Continuous update and accelerated time modes for easy animation.

* Easy-to-use gadtools interface.

1.3   VWorlds.guide/REQUI

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System Requirements
*******************
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The following are the minimum requirements for running VWorlds:

* 256 colour intuition screen.

* 3.5 Mb free RAM (1 Mb chip / 2.5 Mb fast).

* Workbench 3.0.

* 68020 processor.

* Hard disk drive with 2 Mb free space.

The following are recommended:

* Math coprocessor (speeds up the program significantly).

* Multiscan monitor (otherwise you're stuck with an interlaced
  screen).

* Hardware clock (to set the correct time on start-up)

*** Important note for gfx card users ***

VWorlds uses only OS-friendly calls so may work with your gfx card,
depending on the quality of the emulation (hold the shift key down as
the program starts to get a screen mode requester). A couple of people
have reported problems with CyberGfx cards (VWorlds uses intuition calls
involving double buffered/attached screens which are apparently not
emulated).

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1.4 VWorlds.guide/INSTL

Installation
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Installation is easy: simply double-click on the Install icon once
you have unpacked the archive. Installation requires at least 2 Mb free disk
space.

1.5 VWorlds.guide/START

                Getting Started
****

VWorlds can be run from both Workbench and shell. From Workbench, simply
double click on the program icon (either VWorlds_881, if you have a math
coprocessor, or VWorlds, otherwise). If using the shell, you can either
add the program directory to your 'PATH' variable, or copy the executable to the
C: directory, before entering the name of the relevant program. A number of

                Tool Types and CLI arguments
                 are supported.

Before proceeding, you should set your longitude and latitude. This couldn't be
much simpler: select world map mode from the 'Mode' menu, and then click on the
required location. In addition, you may wish to set your time zone so that the
program knows the difference between local time (as shown on the control panel)
and Universal Time (UT). If the time zone correction is left at zero, it will be
assumed that your local time is equal to UT. Use the LT-UT slider gadget to select
your time difference from UT (you can use the 'Show time zone' item from the
'Options' menu in world map mode to guide you). Finally, select 'Save config' from
the 'Project' menu. This will save your preferences in the file 's:VWorlds.config ←
  '.

The program controls are quite straightforward (although you should have a look at
the list of
                Keyboard Shortcuts
                ), and I suggest you dive straight in
and experiment with the program. Try these events for starters:

 * Total solar eclipse (August 11, 1999). Note that the approximate
   outlines of the moon's penumbra and umbra are shaded on the world map,
   making the visualisation of the eclipse path simple. Also, try a view of
   the Earth from the Sun to get a feel for the geometry of the eclipse
   (click on the Sun in the Site listview gadget, and click on Earth in the
   Centre gadget, then zoom in).

 * Total lunar eclipse (September 27, 1996). In telescope mode, the
   Earth's umbra is rendered as a reddish shadow on the face of the moon,
   allowing the progress of the eclipse to be followed. A view of the Earth
   from the Moon will show you at a glance from which areas of the Earth the
   eclipse is visible.

 * Occultation of sigma Sagittarii by Venus (November 17, 1981).
   The BAA handbook lists the UT of disappearance and reappearance for
   Greenwich as 15h 29.5m and 15h 38.2m respectively.

 * Occultation of Mars by Venus (October 13, 1590). Try the views
   from Earth->Venus and Mars->Venus to study this rare event.

 * Earth transit from Mars (November 10, 2084). Select Mars as the
   site and zoom in on the Sun (probably pointless, but you never know, someone
   might be there to see it!).

 * Jupiter and Saturn from Comet Hale-Bopp (any time in 2008) for
   unusual views of these giants.

1.6 VWorlds.guide/TOOLS

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Tool types and CLI arguments
****************************
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The following tool types and (case sensitive) CLI arguments are supported:

```
ET-UT=<Time> (WB + CLI)
    Customize the difference (in seconds) between ephemeris and universal time.
    This varies slowly and generally unpredictably with time due to non-uniform
    rotation of the Earth. The default value is 60 seconds. Overrides the
    setting in 's:VWorlds.config'.

MODE=<MULTISCAN, PAL, NTSC, EURO72, DBLPAL or DBLNTSC> (WB + CLI)
    Instruct VWorlds to use requested screen mode. It is best to choose
    a mode with square pixels on your monitor. You can also select a screen
    mode by holding down either shift key on startup. Overrides the setting
    in 's:VWorlds.config'.

DEPTH5 (WB + CLI)
    Select 32 colour screen, instead of the usual 256 colours. This disables
    all texture mapping, but the program uses much less chip RAM and is faster.

TMSIZE=<1, 2, or 3> (WB + CLI)
    Select the maximum diameter in pixels ('n') of texture-mapped disks. Larger
    values allow larger texture-mapped images, but require more memory. The  ←
        default
```

value is 1 (n=200) which should be fine for most users. If you have lots of
memory (and a fast Amiga) you may like to set this to 2 (n=400), or even 3
(n=800). The amount of extra memory required is roughly (7*n*n) bytes.

? (CLI only)
    Display the template for CLI arguments.

1.7 VWorlds.guide/KEYBD

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KEYBOARD SHORTCUTS
******************
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   * C – Toggle contol panel on/off.
   * B – Toggle title bar on/off.

   * I (SHIFT-I) – Zoom in (quickly).
   * O (SHIFT-O) – Zoom out (quickly).

   * F – Increase animation time-step.
   * S (SHIFT-S) – Decrease animation time-step (stop animation).

   * Y – Activate year string gadget.
   * T (SHIFT-T) – Increment (decrement) month.
   * D (SHIFT-D) – Increment (decrement) day.
   * H (SHIFT-H) – Increment (decrement) hour.
   * M (SHIFT-M) – Increment (decrement) minutes.
   * N – Set to current time.

   * Amiga-S – Save screen
   * Amiga-P – Print screen
   * Amiga-A – Display information about program
   * Amiga-Q or Q – Exit program

   * Amiga-W – World map mode
   * Amiga-L – Planetarium mode
   * Amiga-T – Telescope mode
   * Amiga-O – Orrery mode

   * Amiga-R – Rising time of chart centre.
   * Amiga-E – Setting time of chart centre.

   * 0...9 – Centre view on object (0=Sun, 1=Mercury, 2=Venus,
     3=Moon/Earth, 4=Mars, 5=Jupiter, 6=Saturn, 7=Uranus, 8=Neptune,
     9=Pluto)

   * Cursor keys – Rotate orrery.

   * Shift keys – Hold down to choose a screen mode when the
     program begins.

1.8 VWorlds.guide/COMET

The Comet Database
****

When starting, VWorlds reads comet orbital elements from the file
'comet.dat', and displays the position of these comets in telescope and
orrery modes. If you have elements of a comet you wish to study, these
can be entered into this file using any text editor. The information you
need is,

    * Name

    * Time of perihelion passage.

    * Perihelion distance

    * Eccentricity

    * Inclination

    * Longitude of the ascending node

    * Argument of perihelion

    * Equinox for orbital elements

For efficiency reasons (the comet orbits for orrery mode are calculated when
the program stars, which can be slow), you may only have 5 comets active at
any one time. However, you can store the elements of as many comets you wish
in 'comet.dat' by preceeding the names of comets you are not interested in
with a double backslash "//".

1.9 VWorlds.guide/REFER

The Gadgets
****

Year, month, days, hours, mins
        These will be initialised to your local time when
        the program starts (assuming the system clock is set right!).

LT-UT
        Use this slider gadget to set the difference (in hours) between
        your local time (LT) and universal time (UT).

Faster
        Click on this gadget to increase the time-step by a factor of 8.
        If the Slower gadget is ghosted when you select this gadget, you'll
        be in real-time mode. The maximum time-step corresponds to an update
        rate of about 100 years per second real time. Beyond this, the time-step
        will wrap-around back to zero.

Slower
        Use to decrease the time-step by a factor of 8 (or set to zero if the
        shift key is also held down). The gadget will be ghosted when the

time-step is zero (the program will not eat CPU cycles in this state).

Now

Sets the local time to that currently given by the system clock.

Site

Click on one of the listed objects to move your viewpoint to the position
of that object.

Field

Displays, and allows you to enter, the field of view (in degrees) for
telescope mode.

Zoom In

In world map and telescope modes, decreases the field of view by a factor
of 1.4 (or 10 if the shift key is also held down). In orrery mode, the
viewpoint is moved closer to the Sun, while keeping the field of view fixed
at 40 degrees.

Zoom Out

In world map and telescope modes, decreases the field of view by a factor
of 1.4 (or 10 if the shift key is also held down). The field of view cannot
exceed 60 degrees in telescope mode. In orrery mode, the viewpoint is moved
further from the Sun, while keeping the field of view fixed at 40 degrees.

Centre

Click on one of the listed objects to centre it on the screen, and track it
(telescope mode only).

SAO no.

Enter the SAO number of a star to centre it on the screen (telescope mode
only). Note that only a small fraction of the SAO database is included---
stars brighter than magnitude 7.0, about 15000 stars (to put this in
perspective, the unaided eye can only see stars brighter than about ←
    magnitude
6 in perfect conditions, about 6000 stars). If you enter the number of a
star not in the database, the control screen is flashed.

The Project Menu
****

Save configuration

Save the current setup (longitude, latitude, display mode, field of view,
and virtually everything else!) to the file 's:VWorlds.config'. This file ←
    is
loaded when the program starts.

Save screen

Prompts for a file name and then saves the current screen (the title bar ←
    will
be included in the image, unless you disable it by pressing 'B', and then
save the screen using Amiga-S).

Print screen

Prints the screen to the preferences printer.

Pointing info

Displays a requester with information about the telescope pointing. ↩
    Includes
Julian Date, ET-UT, local sidereal time (hours, minutes, seconds), hour ↩
    angle
of field centre (hours, minutes, seconds), and declination of field centre
(degrees, arcminutes, arcseconds), Some of this information could be useful ↩
     if
(like me) you have a telescope which you wish to point using setting ↩
    circles.

About
        To display a little requester with program info.

Quit
        To exit the program

The Options Menu
****

Show time zone
        If selected, an indication of the extent of the current time zone (as
        determined by the LT-UT setting) will be drawn on the world map. This is
        useful as a guide when setting LT-UT, but is not totally accurate since
        time zone boundaries are generally not simply drawn along lines of
        longitude.

Stars
        Draw stars?

Constellation shapes
        Draw constellation shapes?

Constellation labels
        Draw constellation labels?

Milky way
        Draw Milky Way?

Planet labels
        Write name and distance underneath each planet?

Planet markings
        Draw planet surface detail (including any texture maps)?

Ecliptic
        Draw line along ecliptic (the plane containing the Earth's orbit about
        the Sun)?

Horizon
        Shade area below horizon?

Messier objects
        Mark position of objects from Messier catalogue?

Close Workbench
        Attempt to close the workbench screen? The program guzzles chip memory
        in some display modes. Using this option, you can just about utilise a

very large 256 colour 'Super72' super-hires-laced screen with 2 Mb.
This function fails if another application has windows open on the
workbench screen.

Invert view
        Invert the view in telescope mode to give a view similar to that
        obtained using an astronomical telescope (only applies to views from
        the Earth).

Fast gfx
        Attempt to increase rendering speed by using the CPU for certain graphics
        operations? May give unpredicatble results on systems with graphics cards.

Units
        Select units to be used for objects within 0.5 astronomical units (AU)
        of viewpoint. Either kilometers (KM), or miles (MI).

Orientation
        Select orientation of viewport in telescope mode: (1) horizon, viewport is
        aligned with the horizon at your selected location on earth, (2) equatorial ←
          ,
        viewport is aligned with projection of the earth's equator on the sky, and
        (3) ecliptic, viewport is aligned with the ecliptic.

Grid type
        Overlay the view in telescope mode with a grid in one of three coordinate
        systems: (1) horizon (0 is North, 90 is East, 180 is South, 270 is West),
        (2) equatorial (useful for locating objects on a star chart), and (3)
        ecliptic.

The Mode Menu
****

World map
        Displays a projected map of the world with the observing site marked, and
        twilight/night zones shaded. Also displays position of Moon's shadow if ←
          there
        is a total solar eclipse.

Moon map
        Displays map of Earth with position of Earth->Moon line marked.

Mars map
        Displays map of Mars with position of Earth->Moon line marked.

Planetarium
        Display of major objects above the local horizon. The current telescope
        pointing direction is marked, if above the horizon, with yellow cross-hairs ←
          .
        Clicking on the planetarium sets a new telescope centre and changes to
        telescope mode.

Telescope
        Displays an image of the night sky as you might get with a telescope.

Orrery
        Shows the solar system from a general point in space, looking at the Sun.

```
The Special Menu
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Rising time
      Find rising time of current chart centre on current day. If the object
      is permanently above or below the horizon, the control screen is flashed.

Setting time
      Find setting time of current chart centre on current day. If the object
      is permanently above or below the horizon, the control screen is flashed.

Next new moon
      Set the local time to the time of next new moon.

Next full moon
      Set the local time to the time of next full moon.

Next solar eclipse
      Set the local time to the time of next solar eclipse (whether partial,
      annular or total) anywhere in the world. The eclipse may not be
      visible from your selected position on the world map.

Next lunar eclipse
      Set the local time to the time of next lunar eclipse.

Mercury conjunction
      Set the local time to the time of next inferior conjunction (Mercury
      between Earth and Sun).

Venus conjunction
      Set the local time to the time of next inferior conjunction (Venus
      between Earth and Sun).

Mars opposition
      Set the local time to the time of next opposition (Mars closest to
      Earth on its orbit).

Next occultation
      Set the local time to the time the moon next occults one of the stars
      in the database. Since such occultations are quite common, only those
      events that are visible from your selected position on the world map
      will be selected (Sun must be below horizon and the moon must be
      visible). Only disappearances are calculated, not reappearances.
      Times are generally accurate to within a minute.
```

1.10 VWorlds.guide/QUEST

```
             Frequently asked questions
*************************

Q. How do I change the screen mode that VWorlds uses?

A. There are three possibilities:
```

(1) Hold down either shift key when starting the program. You will be
    presented with a standard screen mode requester listing all the
    modes available. Note that some screen modes are unsuitable for
    use (either because they are low resolution or have non-square pixels).

(2) Edit the project's
        tool types
          .

(3) Enter the desired screen mode using the
        command line
          interface.

Q. VWorlds appears to run correctly but the menus don't have any items.
   What's wrong?

A. You are probably very low on chip memory. Exit the program and try to free
   as much memory as possible.

Q. I'm looking at a planet in telescope mode, but all I get is a blank screen.
   What's wrong?

A. The field of view is probably very small. Try zooming out by pressing shift-O
   several times.

Q. How can I stop animations quickly?

A. Pressing shift-S will stop the animation immediately. Check out the

        keyboard shortcut list
          .

Q. Where can I obtain data for the comet.dat file?

A. Up to date elements for the brighter comets are quite widely available on the
   Worldwide Web. Other resources include books on astronomy/computing (eg. Peter
   Duffett-Smith's book 'Practical Astronomy with Your Calculator'), and the IAU
   circulars.

Q. What is the ecliptic?

A. The ecliptic is the plane containing the orbit of the Earth about the Sun. It
   is useful to plot it since the planets are generally never very far above
   or below.

Q. How accurate is the program?

A. All of the objects and planetary surface markings are rendered to a
   high degree of accuracy, sufficient for most amateur astronomy use. Planetary
   positions are calculated to an accuracy of a few seconds of arc over the
   period 1900-2100. This is sufficient for the prediction of planetary
   occultations, provided they are not grazing the planet disk. The times of
   solar/lunar eclipses are generally accurate to within a couple of minutes.
   Stellar positions take into account proper motion, and are accurate to better
   than 1 arc second. Geocentric positions are corrected for precession, nutation,
   aberration and light-travel time, but not refraction. The positions of the
   satellites of Jupiter should be accurate to better than 0.1 Jupiter radii over

the period 1600-2200. The position of Titan is not so accurate (about 0.5
Saturn radii).

Q. I have a CyberGfx card. Why do I get an error when I try to use a cgfx
   screen?

A. VWorlds apparently uses some intuition calls (those involving double-buffered/
   attached screens) that are not emulated properly. As far as I'm aware, there
   is currently no solution but to resort to an AGA screen mode.

Q. The Moon/planet texture maps disappears when I zoom in. Why?

A. Planets are not texture-mapped if the diameter of the disk is more than
   a certain number of pixels ('n'), but reverts to a polygon rendering method. ←
       This
   is to improve execution speed and reduce memory usage. You can adjust 'n' using
   the
                 command line and tool types
                 .

Q. What are the cross-hairs that are plotted on the Moon and Mars maps?

A. The cross-hairs in the Moon/Mars modes indicate the intersection of
   the planet->Earth line segment with the planet surface. The longitude is ←
       therefore
   the longitude of the central meridian, and the latitude is the tilt of the
   North pole towards the Earth (Mars observers should find this useful!).

Q. The texture-mapped Moon image updates very slowly in animations. Any hints?

A. The texture-mapped images of the Moon and Mars in telescope mode update
   much faster if the screen is oriented with the equator or ecliptic. This is
   because of a code optimisation that is not possible in horizon mode (when the
   images rotate as their position in the sky changes).

Q. How do I change the centre in telescope mode?

A. There are two methods of changing the centre in telescope mode,

   (1) Select an object from the centre listview gadget on the right hand
       side of the control panel. In this case, the object will remain centred
       regardless of the object's motion with respect to the background starfield.

   (2) By clicking on a point in the field of view. The right ascension and
       declination of this point will become the new centre.

   Note: In orrery mode, clicking on the view rotates the viewpoint around the Sun ←
       .

1.11   VWorlds.guide/DISTR

Distribution
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This program is released into the public domain, and may be freely
distributed as long as all document files, program executables and
other binary files are included in their entirety.

Files included in this distribution:

```
    comet.dat               - Comet orbital elements
    earth.map               - Earth texture map (IFF ILBM format)
    Install                 - Installation script
    Install.info            - Icon file
    map.dat                 - World map data
    mars.map                - Mars texture map (IFF ILBM format)
    messier.dat             - Messier object data
    moon.map                - Moon texture map  (IFF ILBM format)
    mw.dat                  - Milky way outline data
    orrery.dat              - Orrery data (planet orbits)
    ReadMe.doc              - Text document
    ReadMe.doc.info         - Icon file
    shape.dat               - Constellation shape data
    stars.dat               - Star data (position, magnitude, proper motion)
    VWorlds_881             - Executable for 68020-40 with FPU
    VWorlds.guide           - Manual
    VWorlds.guide.info      - Icon file
    VWorlds_881.info        - Icon file
    VWorlds                 - Executable for 68020 without FPU
    VWorlds.info            - Icon file
    VWorlds.config          - Configuration file

    extras.info             - Icon file
    extras/VWorlds.info     - MWB-style program icon
    extras/VWorlds2.info    - MWB-style draw icon
    extras/earth.map        - Topographical map of Earth (IFF ILBM format)
    extras/ReadMe.doc       - Extras documentation
    extras/ReadMe.doc.info  - Icon file
```

1.12 VWorlds.guide/HISTY

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Modification History
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```
v1.0    20/3/96     Initial AmiNet release

v1.1    30/3/96     Improved rendering of disk shadows (now not drawn when
                    phase is full). Image of comet nucleus now drawn when you
                    zoom in close. Tidied up rendering of Saturn's shadow on
                    rings (now slightly slower, but looks better). Title bar
                    can now be switched off. Added satellites (Io, Europa,
                    Ganymede, Callisto and Titan). Satellite labels not drawn
                    until you zoom in. Improved the accuracy of the long-term
                    comet ephemeris. Added comet Kohler to database.

                    Minor bug fixes: Corrected orientation of Earth's orbit
                    in orrery mode. Corrected situation where comet may not
                    be rendered when viewed from another comet. Fixed a
                    bug which could cause planets to be only partially
```

rendered, expecially without FPU (never actually observed
it to happen in v1.0, but would have been very noticeable
in this version).

v1.2   31/3/96   Any error messages now displayed in a requester, rather
than being directed to stderr. Can now choose between
miles and kilometers for units. Holding down the shift key
on startup now displays screen mode requester. Saved screens
are now compressed. Preferences file greatly extended---you
can now totally customize how the program starts up.
Messier objects added. Improved accuracy of planetary axis
orientation, and added more detail to planet surfaces.
Added installer script, and CLI interface. New pointing info
requester.

Bug fixes: Corrected error in rendering of Mars polar caps
(introduced in v1.1 embarrassingly). Time zone information
should have been saved in config file, but wasn't---now
fixed. Fixed initialisation of time gadgets (they weren't
initialised to local time in some situations, although
subsequent updates were OK). Adjusted clipping limits in
world map mode---they were a pixel too wide when the title
bar was turned off, causing a MungWall 'hit'.

v2.0   11/4/96   Satellites now not illuminated when eclipsed by primary
(even works for the Moon when viewed from another planet),
and shadows now cast on primary during transit. Improved
accuracy of algorithm for calculating satellite positions.
Improved rendering of Moon during lunar eclipse (shadow now
overlaid on lunar disk), so earth shadow 'object' removed.
New texture maps: Earth (improved), Moon and Mars. Added
Moon and Mars map modes. Can now close Workbench on startup
or during execution. Object rising/setting times now
calculated. Various code optimisations (but program sadly
a bit slower overall due to switch from 32 to 256 colour
screen). Added option to invert view.

Bug fixes: Disk of Sun now rendered if you zoom in close in
orrery mode (broken in v1.2). Fixed screen saving bug (I
hope!).

v2.1   28/4/96   Added 32 colour screen option for users with only 1 Mb chip
memory, or those who want faster screen update (disables
texture mapping). Implemented 'fast graphics' option, which
uses the CPU to render directly into the bitmap for some
functions. Added planetarium mode. Now shows busy pointer
during calculations (except during animations to avoid
constant switching). Added field of view string gadget to
control panel. Texture mapped objects can now be up to
800 pixels in diameter, rather than 200.

Bug fixes: Corrected minor error in handling of menu toggle
items.

1.13   VWorlds.guide/THANX

```
Credits
*******

I would like to thank the following people for their suggestions,
comments and bug reports...

     Christian Wasner          Jeremy Morse
     Carlo Demichelis          Tobias Westenhuber
     Jerome Vuittenez          Henrik Bergstrim
     Frenk Janse               Andy Car
     Dave Jackson              Dan Murrell Jr
     Erwin Knapen              Paul Branney
     Matthew Clemence          Mario Kemper
     Mark Jones

Also, many thanks to...

     Tom Heeren (for the contents of the 'Extras' drawer)
     Simon Edwards (for Image Engineer)
     Jan van den Baard (for GadToolsBox)
```

1.14   VWorlds.guide/AUTHR

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                Author
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If you have any questions about this program (don't forget to check

          the FAQ
          ), use it regularly, or have any suggestions for further
improvements then I would be glad to hear from you. Also, drop me a
line if you want to become a 'registered user' and receive e-mail
notification when new versions are available.

Finally, I'd particularly appreciate contributions of additional
planet/satellite texture maps (these should be standard flat proj-
ections, just like the included '#?.map' files).

          Dr Peter Knight
          E-mail: pak@star.sr.bham.ac.uk
          WWW:    http://www.sr.bham.ac.uk/~pak
```