MV-Plan
User Guide

Version 1.4, 13th July 2006

Conditions of Use

Use of this software is governed by the laws of New South Wales, Australia.

This software is provided free of charge for experienced mixed gas rebreather divers to evaluate m-value gradient profiles based on Erik Baker's m-value gradient calculations and the Buhlmann ZHL16-B decompression model. This software is experimental, it probably contains bugs and should not be relied upon for actual dives. Use it at your own risk.

WARNING

If you follow dive schedules generated by this software you could suffer decompression sickness, serious injury or possibly death. The author does not warrant that this software accurately reflects Buhlmann's algorithms, or that it will produce safe, reliable, results.

Diving in general is fraught with risk, and decompression diving using mixed gases and rebreathers diving adds significantly more risk. This software is not intended for uneducated users. This software and the decompression schedules it produces are tools for experienced mixed-gas rebreather decompression divers only. If you have not been properly trained in mixed-gas rebreather decompression diving by an internationally recognized technical certification agency and/or don't have a firm handle on decompression planning and mixed-gas diving, DO NOT USE THIS SOFTWARE OR THE DIVE SCHEDULES CREATED BY IT.

If you do not understand or do not agree to this statement you must not use this software.

LICENSE

Java™ – is a trademark of Sun Microsystems.

Table of Contents

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Quick Start

This section shows you how to get MV-Plan up and running quickly. More detailed information is given in the Reference section.

The basic steps are:

- Installation
- Conditions of Use;
- Preferences – Set measurement units and user preferences;
- Define Gases;
- Enter Dive Segments;
- Calculate the dive plan;
- Print the dive plan;

Language selection is automatic. If MV-Plan has a language file for your locale it will be used automatically.

If you are interested in helping create a file for your language please email me. The process involves editing a simple text file with translated text.

Installation

MV-Plan is a Java program that can run on any computer with the free Java runtime installed. It has been tested on Mac OS-X, Linux, Windows 2000 and Windows XP, however it should run on any other computer loaded with Sun Microsystems Java Standard Edition version **1.5 or newer**.

When MV-Plan is run it will check that your computer is running the correct version of Java. If your version of Java is too old, shown and you will be requested to upgrade:
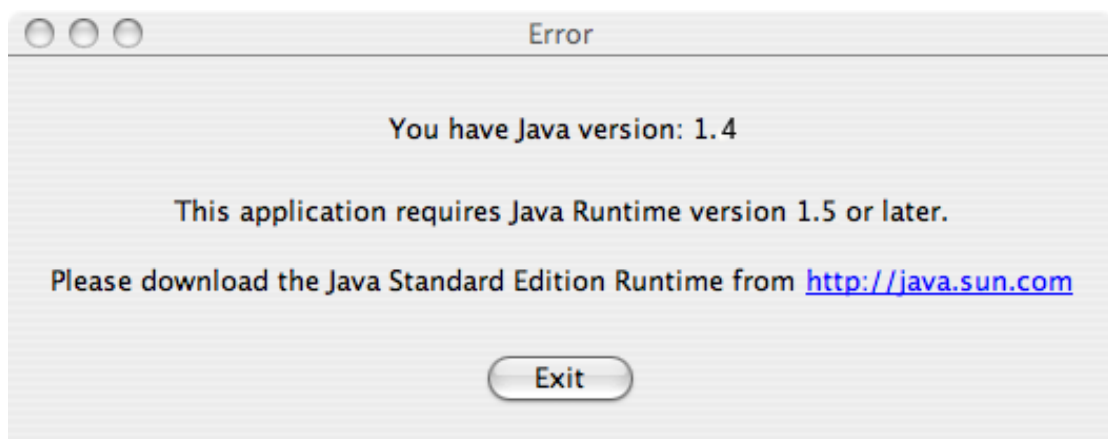
Graphic 1: Java Version

Sun has a web page that will run an Applet in your browser to check that Java is installed and running.

 http://java.com/en/download/help/testvm.xml

If the little guy dances across the screen and the version is 1.5 or greater then you are set up ok. If not then download Java here:

http://www.java.com/en/download/manual.jsp

Whilst Java is a fairly large download you only need to do it once.

Mac Installation

Java is already loaded on Mac OS-X computers 10.3 and above, but the version 1.5 update must be either loaded via the automatic update system, or can be loaded from Apple here:

http://www.apple.com/macosx/features/java/

To install MV-Plan you simply need to download the `mvplan.dmg` disk image file from the web site and do the usual Apple thing:

- Mount the disk volume;
- Drag MV-Plan to you applications folder;
- Run it !

As Java is processor independent MV-Plan will run natively on either PowerPC or Intel Macs !

Windows

After checking your Java version, download the `Mvplan.zip` file and extract the `Mvplan.exe` file. Put this is a convenient location and double click it to run it.

- Download `Mvplan.zip` to your computer;
- Create a folder like:
  `c:/Program Files/Mvplan`
- Unzip `Mvplan.exe` into the folder;
- Optionally create a shortcut for your desktop;
- Double click it to run !

Note: the exe version of Mvplan is simply a java .jar file wrapped in a Windows launcher. This launcher will attempt to find Java prior to running Mvplan. If Java is not properly installed on your computer it will prompt you to visit the sun.com web site and download it.

Linux etc

After checking your Java version download Mvplan.jar to your computer and put it in a convenient location (like a program folder) from where you can run it:

- Download Mvplan.jar to your computer;
- Create a folder like:
  `/home/username/myapps/Mvplan`
- Move `Mvplan.jar` into the folder;
- Optionally create a shortcut for your desktop;
- Double click it to run !

Note: If your Linux computer is not set up to run Java .jar files, you will have to set a file association or run from the command line. The command will be something like this:

`/usr/java/jdk1.5.0_06/jre/bin/java -jar Mvplan.jar`

Upgrading

When upgrading to the new version of MV-Plan simply replace the old `Mvplan.jar` or `Mvplan.exe` file with the new one. All your settings are contained inside the `mvplan.xml` configuration file which typically lives in the same directory as Mvplan.

On a Mac the `mvplan.xml` file is embedded in the application bundle. To preserve your preferences and Dive/Gas settings you need to extract this file from the old application bundle and place it inside the new one in the same location.

> <Ctrl> Click the application icon, select `Show Package Contents`, navigate to `Contents/Resources/Java` and there you will find the file. Copy this file out of the old application bundle and paste it into the new one into the same location.

> If this is too hard then you will need to re-enter your preferences. Sorry.

What is Java ?

Most computer programs have to be written for specific processors and operating systems. This means that there are different versions required for each type of computer. That means a lot of work for developers, and is why most programs are for PC or for Mac, but rarely for both.

Java changes all this by providing a common software environment for programs to run in, independent on the underlying computer. In fact there are versions of Java for devices as small as smart cards or mobile phones, through to mainframe computers. You simply install a copy of the free Java Runtime (JRE) on your computer and it is then capable of running a Java program. In fact most computers already have Java installed, but if not you can download it from Sun Microsystems, the inventors of Java.

Conditions of Use

Prior to using MV-Plan you must read and agree to the **CONDITIONS OF USE**.
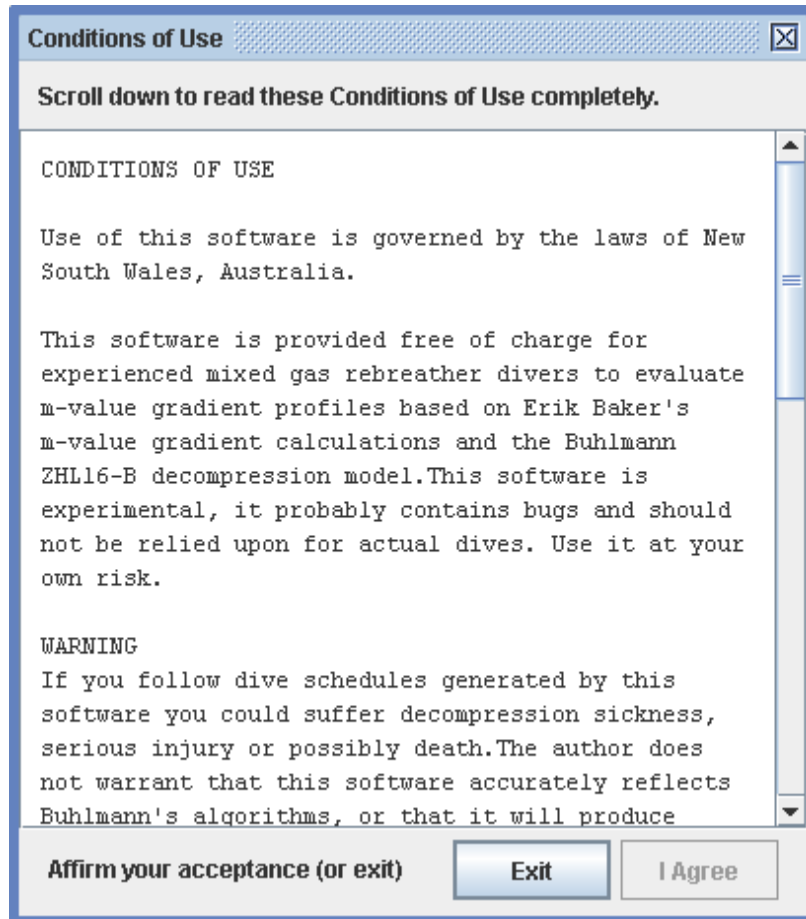
Graphic 2 - Conditions of Use

Scroll down and read the **CONDITIONS OF USE** and affirm your agreement by clicking the I Agree button.

If you do not understand these **CONDITIONS OF USE**, or do not agree with them, you may click exit.

These **CONDITIONS OF USE** are reproduced on page 2 of this User Guide.
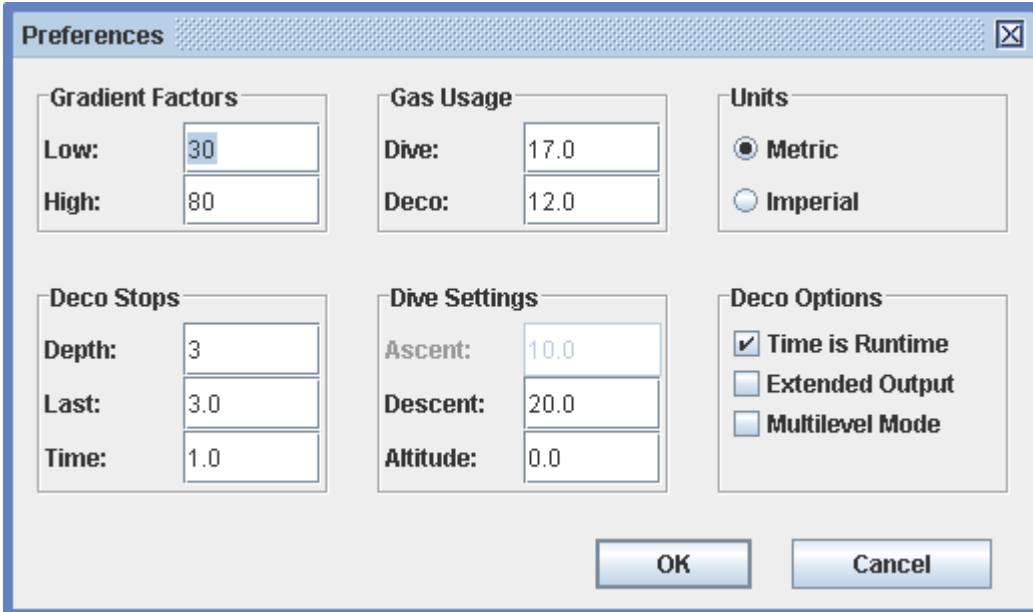
Setup

This section will guide you through a simple setup and first use.

Preferences

Clicking the ⊟ Prefs button on the main toolbar opens the Preferences Dialog, shown below:
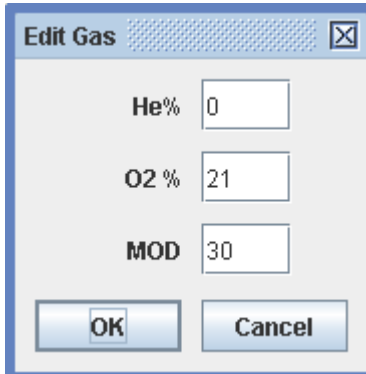
Graphic 3: Preferences Dialog

Here you can set basic operating parameters for MV-Plan. Details of these settings can be found in the Reference section.

Define Gases

Gases must be entered into the Gas List table. If required resize the main window and move the center divider so that it is positioned for your screen size. Click ⊞ to bring up the Gas Popup:

Graphic 4: Gas Popup

Here you enter the Helium fraction and the Oxygen fraction. The remainder is assumed to be Nitrogen.

Pressing <TAB> enters the MOD (Maximum Operating Depth) field. This is automatically calculated as the depth in meters where the gas would deliver a ppO2 of 1.6atm.

MV-Plan uses MOD to initiate a gas switch on open circuit ascent. You can override this MOD and set the depth at which you want MV-Plan to initiate a gas switch.

Click OK to save.
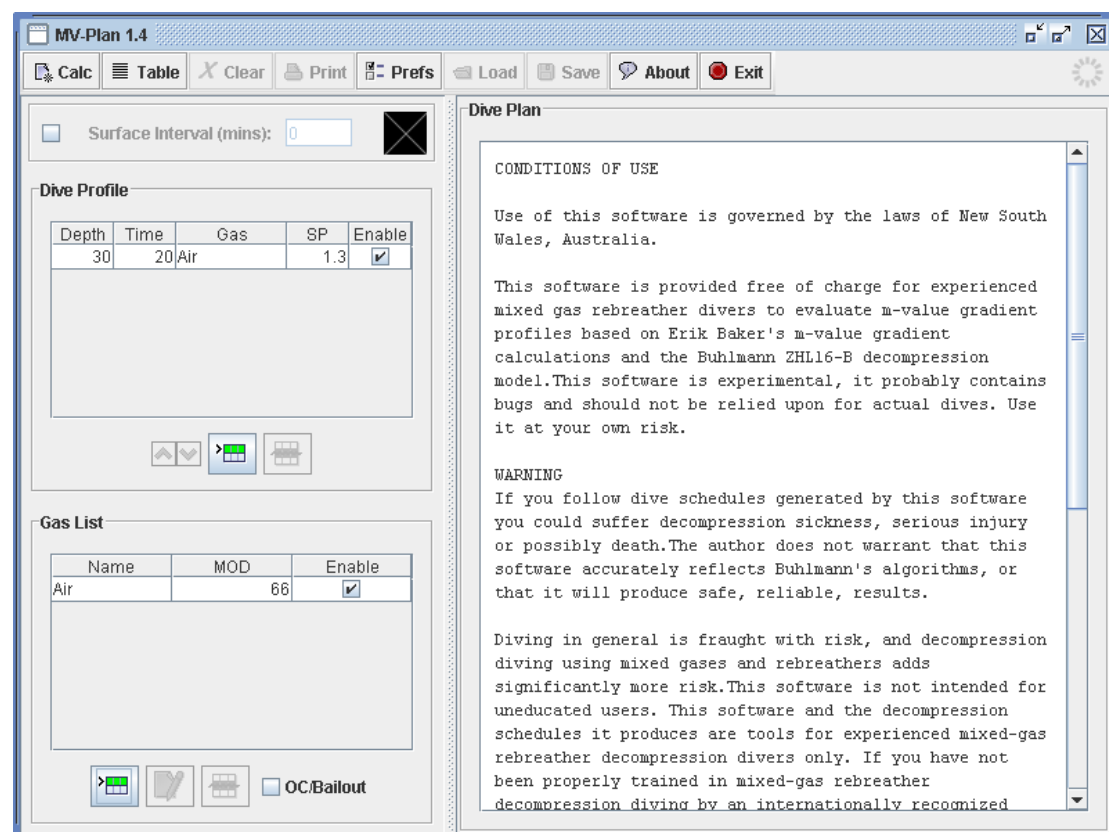
Graphic 5: - MV-Plan Main Screen

Leave the OC/Bailout checkbox deselected at this point.

Enter Dive Segments

Dive segments are entered into the Dive Profile table.

The dive profile is defined as the list of Enabled dive segments, conducted in the order in which they are listed, and then an ascent to the surface.

To add a dive segment click [>] . Enter the details into the blank table row:

Depth – enter depth in meters;

Time – enter time in minutes, or enter zero for a Waypoint (see Reference);

Gas – select a gas from the drop down list (these are the gases entered in the gas table);

SP – enter the setpoint in atm for closed circuit, or enter zero for open circuit;

Enable – select enable to activate this dive segment. Segments that are not enabled are ignored in the current dive profile;

You may use the Up and Down arrows to re-order the dive segments, or click

to delete a segment (remember you can just deselect Enable to ignore a dive segment).

Calculate Dive Plan

Clicking Calc calculates the dive plan and sends it to the output window.

```
MV-Plan 1.4
Settings: GF=10-85 Multilevel=false
     m    Time   Run     Gas    SP
============================
v   048   02:23  002   21/30   1.3
-   048   17:36  020   21/30   1.3
^   027   02:06  022   21/30   1.3
~   027   00:53  023   21/30   1.3
~   024   01:00  024   21/30   1.3
~   021   01:00  025   21/30   1.3
~   018   01:00  026   21/30   1.3
~   015   01:00  027   21/30   1.3
~   012   01:00  028   21/30   1.3
~   009   01:00  029   21/30   1.3
~   006   03:00  032   21/30   1.3
~   003   06:00  038   21/30   1.3


Gas estimate based on Dive RMV =20.0, Deco RMV =12.0L/min
Trimix 8/75 : 0L
Air : 0L
Nitrox 50 : 0L
Oxygen : 0L
Oxygen Toxicity - OTUs: 55 CNS: 21 %

WARNING: This software is experimental
and should not be relied upon for actual dives.
It probably contains errors and may get you bent.
```

This output shows a simple tabular dive plan. The columns are mostly self explanatory, but a couple of points to note:

- The header shows the Gradient factor settings which obviously make a big difference to the dive plan.
- Multi-Level mode status (which is explained in Reference) can also

make a difference for complex dive plans.

- The first column is a visual indicator where:

    v = descend

    ^ = ascend

    – = level dive

    ~ = decompress

- SP: setpoint, or 0.0 for open circuit
- Gas usage is displayed in litres for enabled gases.
  Note: in open circuit mode (SP=0.0) you need to enable the bottom gas to get the volume to display.
- Oxygen toxicity estimates are displayed. Remember these are estimates, see Reference.

An extended output option is also available which shows details of the controlling compartment, M-Values etc. See Reference.

Estimates for open circuit gas usage and oxygen exposure are also shown. (See Reference for a discussion on Oxygen Toxicity calculation methodology).

This text output can be cut and pasted into other documents.

Calculate Dive Series

Clicking ≡ Table allows you to create a series of up to 5 dive plans in a table format.
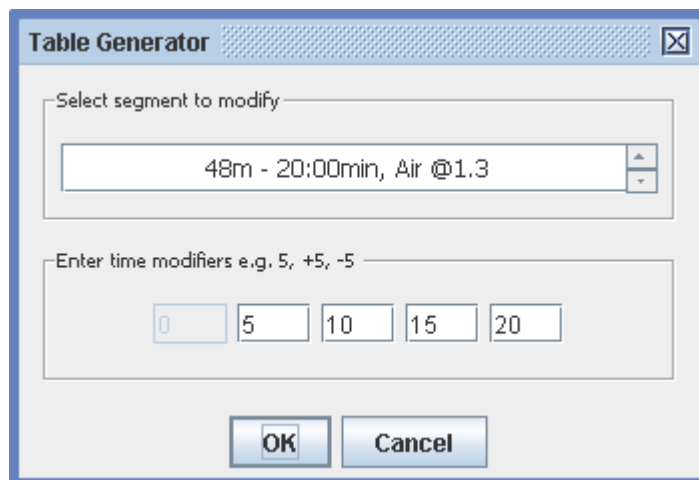
Graphic 6: Specify Dive Table

MV-Plan identifies the last dive segment specified (excluding way points) for modification of the Time. Any non-zero dive segment can be used as the basis for the dive table. Other dive segments are available via the selectors.

Graphic 6 shows the 48m 20min segment selected. The first dive calculated will be the nominal time, then up to another 4 dives will be calculated by

applying the time modifiers to the specified Time. In this case dive schedules will be created for 20min, 22min, 25min, 27min and 30min.

Entering a zero time modifier will cut the table off at that point onwards. E.G. To specify only 3 dive times, enter zero in the 4th box.

```
MV-Plan 1.4
Settings: GF=10-85 Multilevel=false
   m    R    R    R    R    R   SP    Gas
------------------------------------------
  48    2    2    2    2    2  1.3  21/30
  48   20   22   25   27   30  1.3  21/30
  30                        33  1.3  21/30
  27   23   25   29   31   34  1.3  21/30
  24   24   26   30   32   35  1.3  21/30
  21   25   27   31   33   36  1.3  21/30
  18   26   28   32   34   37  1.3  21/30
  15   27   29   33   35   38  1.3  21/30
  12   28   30   34   37   41  1.3  21/30
   9   29   32   37   40   45  1.3  21/30
   6   32   36   42   45   51  1.3  21/30
   3   38   42   49   53   60  1.3  21/30


Oxygen Toxicity - Max CNS: 33 %


WARNING: This software is experimental
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It probably contains errors and may get you bent.
```

This text output can be cut and paste into other documents. It shows the Run times and, optionally, Stop times, if selected in the Print Preview dialog.

The CNS% shown is the maximum encountered on any dive plan. If this exceeds safe limits you should investigate further by calculating each individual dive plan.

Print a dive table

When you are satisfied with the dive plan you can print a ready-to-laminate version. Press the [🖨 Print] button to display the Dive Profile:
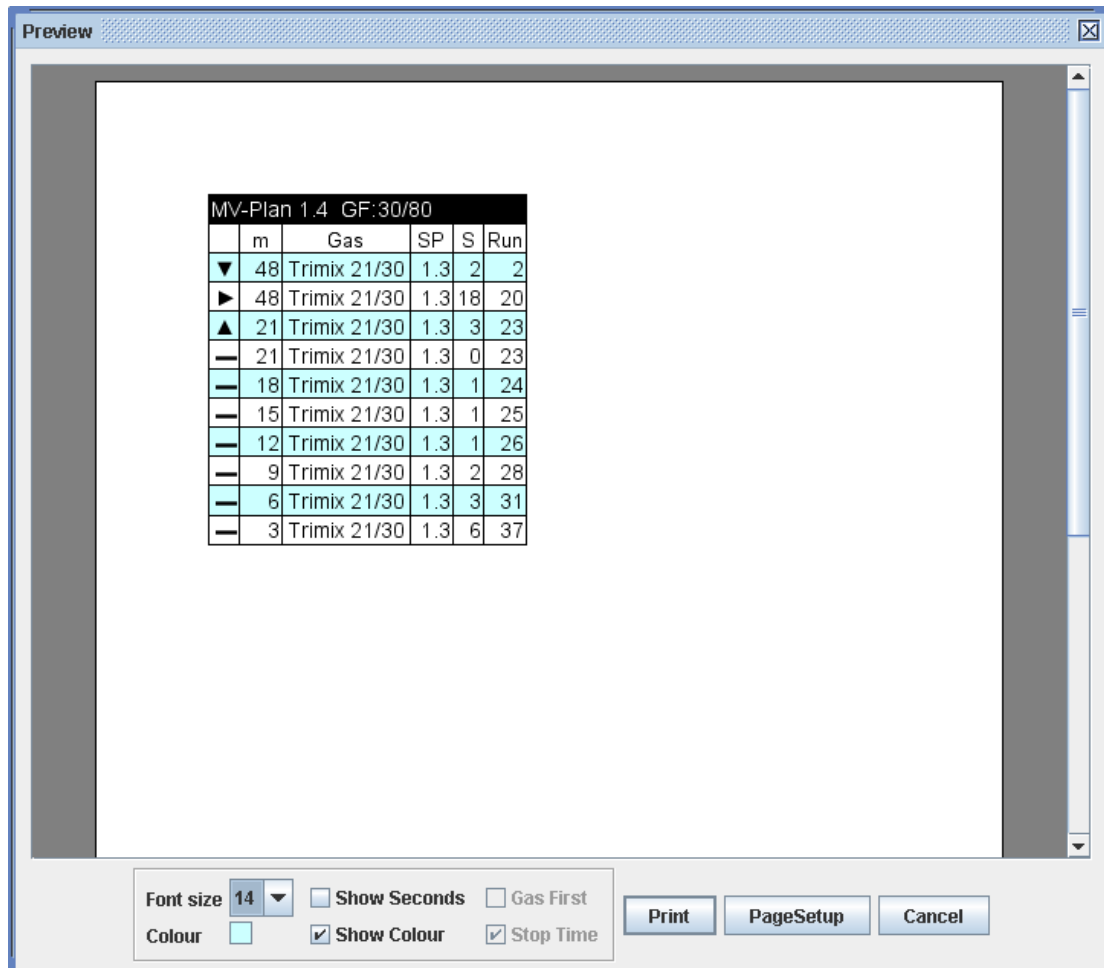
Graphic 7: - Print Preview Single Dive

Print options available are:

- **Font size:** select 9, 10, 12 or 14 to change the size of the dive table;
- **Colour**: click the colour patch to change the colour of the shading in the table;
- **Show seconds**: click to show seconds (single dive table only);
- **Show colour:** click to enable the alternating colours;
- **Gas First:** click to change the column order for multi dive tables;
- **Stop Time:** click to show or hide stop times on multi dive tables.

MV-Plan 1.4 GF:30/80

m	R	R	R	R	R	Gas	SP
48	2	2	2	2	2	21/30	1.3
48	20	23	25	27	30	21/30	1.3
24					33	21/30	1.3
21	23	26	28	31	34	21/30	1.3
18	24	27	29	32	35	21/30	1.3
15	25	28	31	34	37	21/30	1.3
12	26	30	33	36	40	21/30	1.3
9	28	33	36	39	44	21/30	1.3
6	31	37	41	45	50	21/30	1.3
3	37	44	48	53	60	21/30	1.3

Font size 14 ▼   ☐ Show Seconds   ☐ Gas First
Colour ☐   ☑ Show Colour   ☐ Stop Time

Print   PageSetup   Cancel
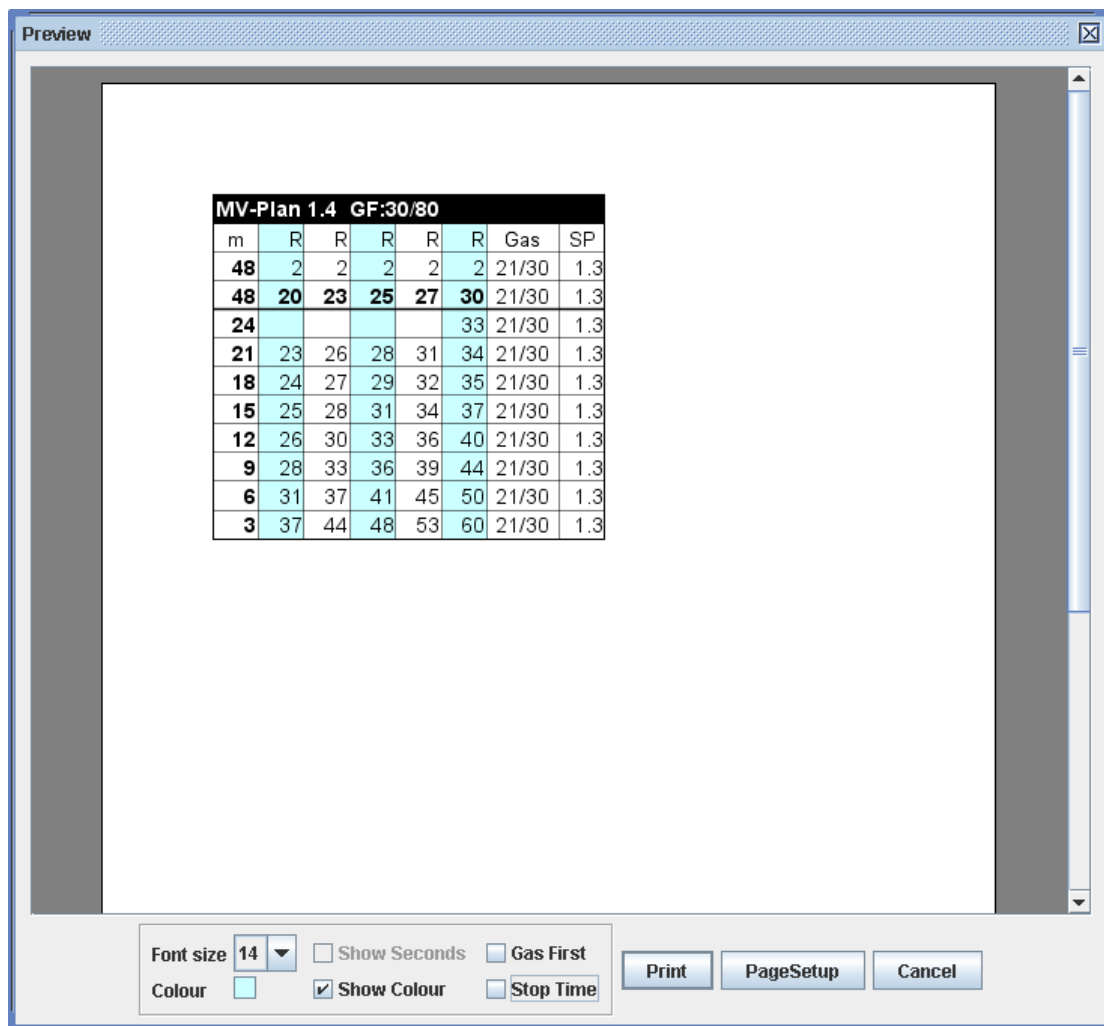
Graphic 8 - Print Preview Multi Dive Table

These tables are designed to be laminated. To alter the size of the resulting table change the font size. The font size controls the table size.

The following section goes through specific cases that show you how to use some of the more detailed operations.

Usage Examples

Open Circuit Decompression Dive
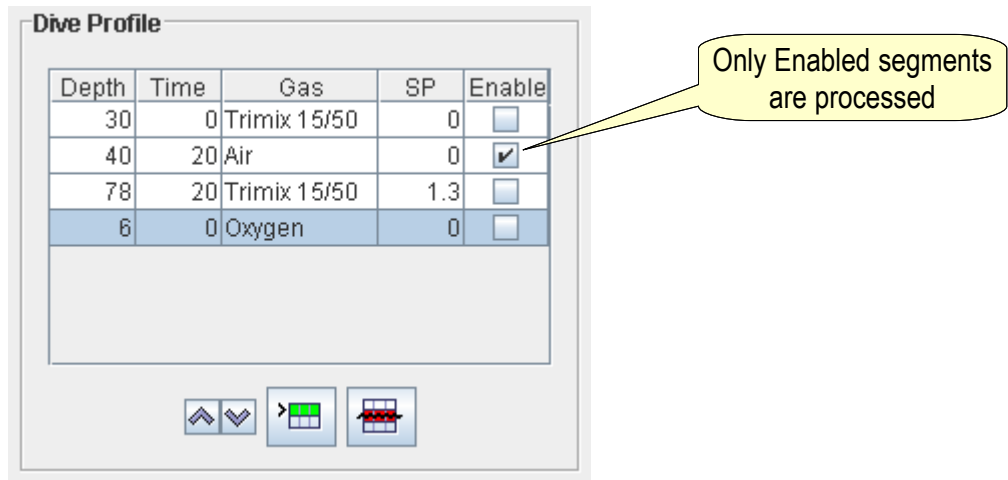
In this example the plan is to conduct a dive to 40m on Air, and decompress on 50% Nitrox. Enter a dive segment as shown:
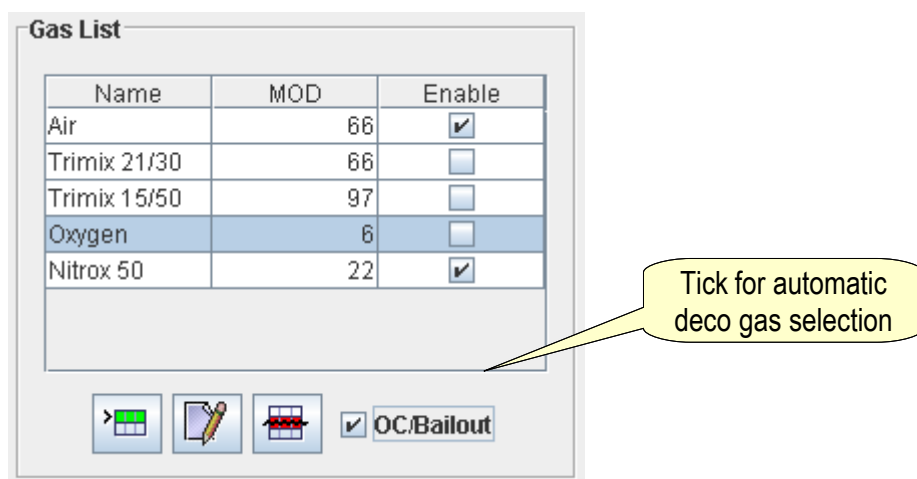
Depth	Time	Gas	SP	Enable
30	0	Trimix 15/50	0	☐
40	20	Air	0	☑
78	20	Trimix 15/50	1.3	☐
6	0	Oxygen	0	☐

Only Enabled segments are processed

Graphic 9: Dive Profile

Points to note:

- Setpoint (SP) is set to 0, indicating open circuit;
- Only this segment is Enabled;

Enable the Air and Nitrox 50 Gases for open circuit use, and select OC/Bailout to indicate that you want MV-Plan to automatically change gases on ascent.

Name	MOD	Enable
Air	66	☑
Trimix 21/30	66	☐
Trimix 15/50	97	☐
Oxygen	6	☐
Nitrox 50	22	☑

☑ OC/Bailout

Tick for automatic deco gas selection

Graphic 10: Gas List

OC/Bailout is used to tell MV-Plan to automatically select gases from the Gas

List on ascent. This is appropriate for open circuit dives where you will use decompression gases, or for open circuit bailouts from a closed circuit dive.

OC/Bailout should be left deselected for dives where you wish to continue to the surface using the same gas as you were using on the bottom.
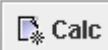
Note that only Enabled gases are automatically selected, and they are used at the next stop depth above the specified MOD.

Press [Calc] for the open circuit dive plan with automatic selection of Air and Nitrox 50.

```
MV-Plan 1.4
Settings: GF=30-85 Multilevel=false
     m   Time   Run    Gas   SP
    ============================
v  040  02:00  002     21   0.0
-  040  18:00  020     21   0.0
^  021  01:53  022     21   0.0
^  018  00:18  022     50   0.0
~  018  00:47  023     50   0.0
~  015  01:00  024     50   0.0
~  012  01:00  025     50   0.0
~  009  01:00  026     50   0.0
~  006  02:00  028     50   0.0
~  003  05:00  033     50   0.0


Gas estimate based on Dive RMV =20.0, Deco RMV =12.0 l/min
Air : 2073 l
Nitrox 50 : 240 l
Oxygen Toxicity - OTUs: 28 CNS: 11 %

WARNING: This software is experimental
and should not be relied upon for actual dives.
It probably contains errors and may get you bent.
```

Points to note:
- This dive used gradient factors of 30/85;
- SP is zero, indicating that this is an open circuit dive;
- The initial ascent (indicated by ^) is to 21m on Air
- Gas switches to 50% at 21m, being the first stop depth at or above the Maximum Operating Depth (MOD) specified for Nitrox 50;
- Total runtime is 33mins;
- Gas estimates are shown for the Respiratory Minute Volume (RMV) numbers specified in Preferences;
- Oxygen Toxicity estimates are shown.

Closed Circuit Decompression Dive

In this example the objective is to conduct a closed circuit dive to 78m for 20mins on Trimix 15/50.

As this dive is deeper lets change some Preferences:

- Gradient factors changed to 15/80;
- Last stop depth changed to 6.0m

Graphic 11: Preferences

Now set the dive profile:

- Setpoint is set to 1.3;
- Only this segment is enabled. The others can stay there, they are just ignored.

Graphic 12: Dive Profile

Note that MV-Plan does not have a starting Set Point like some other software. It really makes no difference. But if you insist in doing this enter two initial waypoints:

```
0.0  meters 0.0 mins     SP 0.7

15.0 meters 0.0 mins     SP 1.3
```

This time we de-select the OC/Bailout option as we are planning to dive the whole way on Closed circuit. It does not matter what gases are Enabled at this point, because unless the OC/Bailout box is selected they will not be used.

Press [⧉ Calc] to generate the dive plan:

```
MV-Plan 1.4
Settings: GF=15-80 Multilevel=false
     m    Time   Run    Gas    SP
============================
v  078  03:53  004  15/50  1.3
-  078  16:06  020  15/50  1.3
^  048  03:00  023  15/50  1.3
~  048  00:59  024  15/50  1.3
~  045  01:00  025  15/50  1.3
~  042  01:00  026  15/50  1.3
~  039  01:00  027  15/50  1.3
~  036  01:00  028  15/50  1.3
~  033  01:00  029  15/50  1.3
~  030  01:00  030  15/50  1.3
~  027  02:00  032  15/50  1.3
~  024  02:00  034  15/50  1.3
~  021  03:00  037  15/50  1.3
~  018  03:00  040  15/50  1.3
~  015  05:00  045  15/50  1.3
~  012  06:00  051  15/50  1.3
~  009  08:00  059  15/50  1.3
~  006  34:00  093  15/50  1.3

Gas estimate based on Dive RMV =20.0, Deco RMV =12.0 l/min
```

```
Air : 0 l
Nitrox 50 : 0 l
Oxygen Toxicity - OTUs: 137 CNS: 51 %

WARNING: This software is experimental
and should not be relied upon for actual dives.
It probably contains errors and may get you bent.
```

Points to note:

- SP is 1.3 all the way indicating that this is a fully closed circuit dive;
- Last stop is now 6.0 meters

Now lets work out the bailout plan. Assume we have three gases available:

- Our diluent Trimix 50/15;
- Our bailout Air;
- Our onboard Oxygen.

Enable the following gases and the OC/Bailout option:
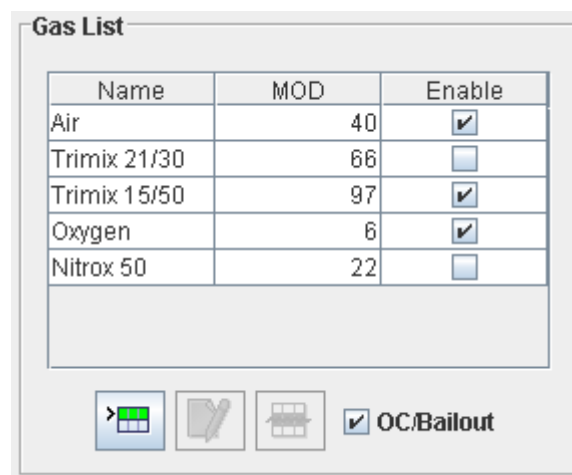
Graphic 13: Gas List for Bailout

Note that I have also edited Air and set it's MOD to 40m. This tells MV-Plan not to switch to Air until the next stop equal to or shallower than 40m.

Press **Calc** to generate the Bailout plan:

```
MV-Plan 1.4
Settings: GF=15-80 Multilevel=false
     m   Time  Run    Gas    SP
============================
v  078  03:53  004   15/50  1.3
-  078  16:06  020   15/50  1.3
^  048  03:00  023   15/50  0.0
~  048  00:59  024   15/50  0.0
~  045  01:00  025   15/50  0.0
~  042  01:00  026   15/50  0.0
~  039  01:00  027      21  0.0
```

```
~  036  01:00  028     21  0.0
~  033  01:00  029     21  0.0
~  030  01:00  030     21  0.0
~  027  01:00  031     21  0.0
~  024  01:00  032     21  0.0
~  021  03:00  035     21  0.0
~  018  03:00  038     21  0.0
~  015  05:00  043     21  0.0
~  012  07:00  050     21  0.0
~  009  11:00  061     21  0.0
~  006  31:00  092    100  0.0

Gas estimate based on Dive RMV =20.0, Deco RMV =12.0 l/min
Trimix 15/50 : 635 l
Air : 1096 l
Oxygen : 595 l
Oxygen Toxicity - OTUs: 98 CNS: 85 %

WARNING: This software is experimental
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```

Points to note:

- You can see the first two lines show the closed circuit part of the dive as planned;

- Then the bailout commences with an ascent to the first deco stop on Open Circuit Trimix;

- When the MOD for air is reached the plan switches to air.

- The final stop is on Oxygen.

- Gas estimates are given as this dive includes open circuit components;

Note: Gas consumption can be very high on bailouts. Conservative RMV values should be selected.

	m	Gas	SP	S	Run
▼	74	Trimix 15/50	1.3	4	4
▶	74	Trimix 15/50	1.3	16	20
▲	45	Trimix 15/50	1.3	3	23
—	45	Trimix 15/50	1.3	1	24
—	42	Trimix 15/50	1.3	1	25
—	39	Trimix 15/50	1.3	1	26
—	36	Trimix 15/50	1.3	1	27
—	33	Trimix 15/50	1.3	1	28
—	30	Trimix 15/50	1.3	1	29
—	27	Trimix 15/50	1.3	1	30
—	24	Trimix 15/50	1.3	2	32
—	21	Trimix 15/50	1.3	3	35
—	18	Trimix 15/50	1.3	2	37
—	15	Trimix 15/50	1.3	5	42
—	12	Trimix 15/50	1.3	5	47
—	9	Trimix 15/50	1.3	7	54
—	6	Trimix 15/50	1.3	31	85

MV-Plan 1.2   GF:15/80

	m	Gas	SP	S	Run
▼	74	Trimix 15/50	1.3	4	4
▶	74	Trimix 15/50	1.3	16	20
▲	48	Trimix 15/50	0.0	3	23
▲	45	Air	0.0	0	23
—	45	Air	0.0	1	24
—	42	Air	0.0	1	25
—	39	Air	0.0	1	26
—	36	Air	0.0	1	27
—	33	Air	0.0	1	28
—	30	Air	0.0	1	29
—	27	Air	0.0	1	30
—	24	Air	0.0	1	31
—	21	Air	0.0	1	32
—	18	Air	0.0	3	35
—	15	Air	0.0	4	39
—	12	Air	0.0	6	45
—	9	Air	0.0	10	55
—	6	Oxygen	0.0	27	82

Graphic 14: Ready to laminate dive plan

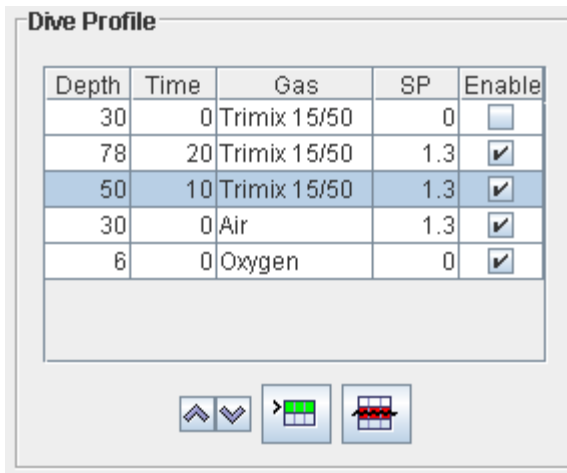Now we can print and laminate our dive plans back to back.

Complex waypoints

MV-Plan allows you to string together a number of dive segments and way points to define a complex dive profile. A waypoint is simply a dive segment with zero time and it allows you to change gases, setpoints or to switch between open and closed circuit.

For this example I will show a complex dive that illustrates a number of these points.

- Dive to 78m for 20mins on Trimix;
- Ascend to 50m and continue at that depth for another 10 minutes;
- Switch to air diluent at 30m;
- Go to open circuit oxygen at 6m.

This illustrates the ability to string together multiple dive segments (78m and 50m), the ability to use a waypoint for a diluent change (30m) and the ability to use a waypoint to switch to open circuit (6m).

Graphic 15: Complex Dive Profile

The dive plan generated is shown below. Some points to notice:

- Observe the stop indicator to see whether it is an ascent (^), a dive (-) or a deco (~) segment
- Observe the SP to see whether it is a closed or open circuit segment;
- Observe the Gas changes;
- You will also note that the CNS% exceeds 100% for this dive. Please see the section on Oxygen Toxicity in the Reference section, MV-Plan does not calculate air breaks, this is up to you !

```
MV-Plan 1.3
Settings: GF=15-80 Multilevel=false
      m   Time  Run    Gas    SP
============================
v  078  03:53  004   15/50   1.3
-  078  16:06  020   15/50   1.3
^  050  02:47  023   15/50   1.3
-  050  10:00  033   15/50   1.3
^  036  01:23  034   15/50   1.3
~  036  01:47  036   15/50   1.3
~  033  01:00  037   15/50   1.3
-  030  00:00  037      21   1.3
~  030  01:00  038      21   1.3
~  027  02:00  040      21   1.3
~  024  01:00  041      21   1.3
~  021  03:00  044      21   1.3
~  018  03:00  047      21   1.3
~  015  05:00  052      21   1.3
~  012  06:00  058      21   1.3
~  009  08:00  066      21   1.3
-  006  00:00  066     100   0.0
~  006  33:00  099     100   0.0


Gas estimate based on Dive RMV =20.0, Deco RMV =12.0 l/min
Trimix 15/50 : 0 l
Air : 0 l
Oxygen : 633 l
Oxygen Toxicity - OTUs: 158 CNS: 109 %


WARNING: This software is experimental
and should not be relied upon for actual dives.
It probably contains errors and may get you bent.
```

Note:

1.Under certain circumstances you may need to set Multi-Level mode in the preferences. Please see the Reference section for an explanation of this.

2. A bailout plan for a complex dive like this cannot simply be obtained by selecting OC/Bailout. MV-Plan will bailout after the last segment (6m) which is not much use. You need to go back and explicitly plan how you want to bailout.

Repetitive Dive

MV-Plan allows you to retain model data after a dive, to save it to a file, and to use it for planning repetitive dives.

The repetitive dive panel enables this function when the checkbox is ticked.

Graphic 16: Repetitive Dive

The tissue indicator shows the model status upon surfacing:
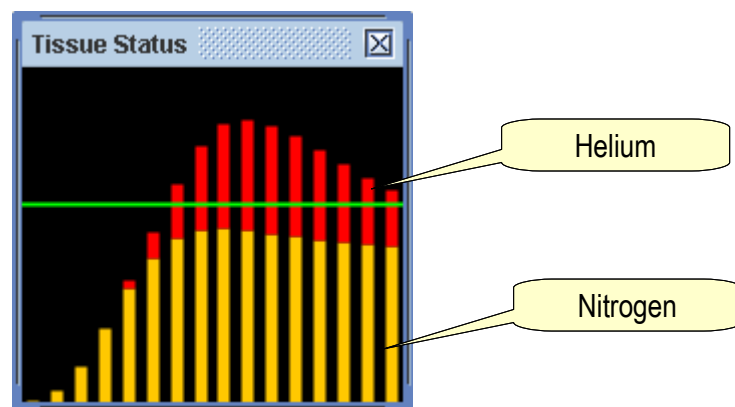
   Model is clear

   Model is loaded

Click on the tissue indicator to bring up a larger version in a new window.

Graphic 17: Tissue Status

The tissue status window can be stretched to a larger size and actual compartment numbers and pressures will be shown. Orange bars represent the partial pressure of nitrogen, and the red bars helium. The green line represents ambient pressure.

To plan a repetitive dive, do the following:

- Select repetitive dive mode by selecting the checkbox;
- Ensure the model is clear, or press the Clear button on the toolbar;
- Plan the first dive. The model status shows that the model is loaded;
- Optionally save the model data to a file for later use;

- Enter a surface interval in minutes;
- Adjust the profile and gases for the second dive;
- Calculate the second dive;
- This process can be repeated for third or multi-day dives as required.

Points to note:

- The dive plan window maintains the history of the dives planned in the current session;
- When you save the model data enter a sensible file name (like *Dive 100.xml)*, and you can also enter a description that is embedded into the file. When you load the model data again this description is displayed in the dive plan window to remind you of where the repetitive model data came from; The display below shows a previous dive's model loaded and used as the starting point for planning a subsequent dive.

```
Model loaded: Dive to 50.0 for 20.0 on Colooli on 24-May-2005
Model updated with Surface Interval of 60 mins.

*** REPETITIVE DIVE ***

MV-Plan 1.3
Surface Interval :60 mins.
Settings: GF=15-80 Multilevel=false
     m   Time  Run    Gas   SP
==============================
v  030  01:30  002     21  1.3
-  030  23:30  025     21  1.3
^  012  01:48  027     21  1.3
~  012  01:11  028     21  1.3
~  009  01:00  029     21  1.3
~  006  01:00  030     21  1.3

Gas estimate based on Dive RMV =20.0, Deco RMV =12.0 l/min
Trimix 15/50 : 0 l
Air : 0 l
Oxygen : 0 l
Oxygen Toxicity - OTUs: 110 CNS: 32 %

WARNING: This software is experimental
and should not be relied upon for actual dives.
It probably contains errors and may get you bent.
```

- Any Dive Profile printed will show a Surface Interval (SI) on the top line. Remember that this profile is specific to the repetitive dive sequence and should not be kept as a standard dive plan !

	m	Gas	SP	S	Run
▼	30	Air	1.3	2	2
▶	30	Air	1.3	24	25
▲	12	Air	0.0	2	27
—	12	Air	0.0	4	31
—	9	Air	0.0	1	32
—	6	Oxygen	0.0	1	33

MV-Plan 1.2   GF:15/80   SI:60

SI:60 shows this is a repetitive dive

Graphic 18: Repetitive Dive

Note that keeping track of multiple dives over multiple days is possible, but certainly requires some discipline in keeping accurate records. It is up to you to do this correctly !

Reference

This section discusses some of the technical aspects of the operation of MV-Plan and then goes through each option in detail.

Decompression Discussion

MV-Plan is based on the Buhlmann ZHL-16B algorithm with Erik Baker's M-Value gradient method for conservatism.

The M-Value is the maximum compartment overpressure permitted by Buhlmann before significant bubble formation is likely to occur. Strict adherence to his model and these M-values is likely to get the average fit diver bent about 5% of the time. As such most deco programs have some level of conservatism built in, and Buhlmann himself recommends this.

Erik Baker proposed a method of scaling back these M-Values as you ascend from your dive. This M-Value gradient method defines a starting and ending gradient factor which is progressively applied as you ascend from a dive. So for gradient factor settings of 30/80 your first stop is determined to be the depth at which you would penetrate only 30% into the overpressure limit defined by Buhlmann, your next stop a little more, until at your final stop you get to 80% of the M-value.

This effectively adds conservatism in a way that is based on some objective methodology.

For further reading look for a copy of Erik Baker's paper *Understanding M-Values* on his web site: http://www.decompression.org/baker/home.htm

MV-Plan aims to implement Buhlmann and Baker's methodologies but it should be recognised that there is a fair bit of interpretation required on the details of implementation. That is why there will often be a small difference in the stop times calculated by different deco programs.

This table lists some of the implementation details that I have used:

Description	Implementation
Respiratory co-efficient (Rq)	Partial pressure of water vapour in Alveolar gas effectively reduces the partial pressure of inspired gas. This has a significant impact on deco times, especially with rebreathers. MV-Plan uses an Rq of 1.0 (being Buhlmann's number and representing a partial pressure of water vapour of 0.627msw).
Deco Steps	For simplicity MV-Plan assumes instantaneous ascent between deco stops.

Description	Implementation
M-Value Gradient selection	MV-Plan sets the M-Value Gradient (low) the first time that it encounters a deco stop. From then on every time you move shallower it reduces the gradient. This can cause some confusion on dives with a series of complex waypoints when you go up and down and decompress between dive levels.
	This is why the "Multi-Level Mode" option is required. In this case MV-Plan holds the M-Value Gradient at the low setting until the last dive segment is executed and the final ascent begins. See Reference information for examples.
Diluent ppO2 exceeds setpoint	If you specify a diluent with a ppO2 in excess of the setpoint MV-Plan assumes that you breathe the mix *down* to the setpoint, thus increasing the partial pressure of inert gas.
	In fact the ppO2 will spike first and then decay to the setpoint in an in-determinant manner. The model's behaviour is conservative from a decompression point of view but does not calculate the increased oxygen toxicity. Obviously it is better that you select a more appropriate diluent.
Diluent is oxygen and depth is greater than setpoint	If you specify that the diluent is oxygen and the setpoint is 1.3, but the depth is 6m. The model assumes that you are breathing a higher ppO2 than your setpoint and uses 1.6atm as the ppO2. There is no real issue with this from a model perspective.
Diluent is oxygen and depth is less than setpoint	If you specify that the diluent is oxygen, the setpoint is 1.6, and the final deco stop is 3m. The model assumes that you are breathing oxygen at the depth specified and uses a ppO2 of 1.3atm. There is no real issue with this from a model perspective.

Description	Implementation
Altitude Calculations	If you specify an altitude in the Preferences Dialog MV-Plan will adjust the absolute pressures used in the decompression calculations. This has the effect of reducing the absolute pressure at depth, and reducing the air pressure on surfacing.
	MV-Plan assumes that you are using a calibrated depth gauge that indicates the correct depth at altitude. An analogue depth gauge does not provide this compensation. For example at 3000m the atmospheric pressure is 0.69bar. So at 3m underwater an analogue gauge will read zero depth.
	When using closed circuit at altitude MV-Plan will maintain the correct absolute setpoint. So at an altitude of 3000m, when at a deco stop of 6m, the absolute pressure is:
	6msw + 0.69bar = 1.29bar absolute.
	A rebreather set 1.3bar will not be able to reach setpoint.
	MV-Plan will assume that at any deco depth where the absolute pressure is below setpoint you are breathing pure oxygen at the absolute pressure (less water vapour pressure).
Oxygen Toxicity Calculations	MV-Plan calculates CNS% using a table method, just like you do manually. So for a exposure of 1.51 to 1.60 ppO2 your CNS clock ticks at a rate of 60/45 % per minute.
	If you have an exposure of greater than 1.6 atm MV-Plan quickly adds to your CNS% so as to show you that you have a problem, but any exposure of > 1.6 atm is not well defined and should be considered inaccurate. That is why a specific warning is displayed.

Choosing Gradient factors

Selection of appropriate gradient factors is an important consideration in using MV-Plan. As I am not a diving instructor I cannot give specific recommendations as to what numbers to use, but can offer some general advice:

- The lower the number the more conservative, to the point where a GF of 0.0 means that MV-Plan will not allow any compartment to exceed ambient pressure (probably not practical);

- More conservative gradient factors should be used on deep trimix dives e.g. 15/80;

- Numbers in common use for moderate exposure decompression dives seem to be of the order of 30/85;

- If you are using an Evolution rebreather you could review section 11.2 of the manual that gives specific recommendations on gradient factors for different types of dives; It can be downloaded here: http://www.apdiving.com/evomanual/Evolution Instruction Manual 0505.pdf

- MV-Plan will allow a GF of up to 95%, being more or less nominal Buhlmann, but this is not recommended !

- I suggest you also read Erik Baker's paper *Confusion About Deep Stops* on his web site: http://www.decompression.org/baker/home.htm

- Above all ask your diving instructor for recommendations on suitable numbers for your needs;

A Reality Check

Decompression theory is an approximation and should not be confused with the real world. It is entirely probable that you could dive with all the conservatism in these models and still suffer decompression sickness. There are many variables and even day to day variations in your personal physiological response to the dive.

It is not my place to tell experienced divers how to dive, but never the less MV-Plan has some built in limits to depth, time and setpoints. Even so it will allow you to enter dive profiles that are in the extreme range. It must be recognised that the Buhlmann model is not well validated for extreme dives, especially extreme trimix/closed circuit dives, and you are certainly risking decompression sickness or death when conducting this type of dive. Further more there has been no long term study on the effect of gradient factor conservatism, and although it is more conservative than straight Buhlmann this cannot be proven. As such, as stated in the CONDITIONS OF USE, this software should be considered experimental and used only to compare gradient factors to traditional decompression procedures.

Under no circumstances should you rely on the decompression schedules generated by MV-Plan, especially if it produces

decompression schedules more aggressive than traditional procedures.

The fact is that if you regularly do decompression diving you *will get bent to some degree, someday*. In fact, although I have never been bent, 90% of my diving buddies have been bent to some degree.

MV-Plan does not provide extra options for conservatism, other types of deep stops etc, as this is just putting approximations on top of approximations. In other words, *Putting Lipstick on a Pig*. (No matter how you pretty it up, it is still a pig).

So where you see the pig you know what I mean.

Operation

This section describes each option in detail.

Dive Profile

The dive profile area on the main screen lets you enter multiple dive segments. Segments are recognised and processed in order when they are enabled, but commonly used segments may be left there Disabled for later use.

Graphic 19: Dive Profile

The field descriptions are:

Depth: The segment depth in meters. Depth is limited to 100m.

Time: The segment time in minutes. Time is limited to 100min.

Gas: The segment gas, as defined in the Gas List;

SP: The segment Set Point (in atmospheres of oxygen). SP is limited to 1.6.
Leave this zero to indicate open circuit;

Enable:Indicates that this segment is to be used in the dive;

The Controls are:

⌃   Moves the segment up in the list, thus defining its order

⌄   Moves the segment down in the list;

▣   Adds a new segment;

▣   Deletes the currently selected segment;

Gas List

The Gas List defines the gases that you want to use. Before a gas can be used in the Dive Profile it must be defined here. Furthermore this list specifies which gases are enabled for use in open circuit mode.

Name	MOD	Enable
Air	40	✔
Trimix 21/30	66	☐
Trimix 15/50	97	✔
Oxygen	6	✔
Nitrox 50	22	☐

Graphic 20: Gas List

The field descriptions are:

Name: Automatically determined from the gas composition;

MOD: The depth at which the gas will be automatically selected during ascents. This is entered in the gas popup or is automatically calculated for a ppO2 of 1.6
Note that there is nothing to stop you specifying a gas to be used in excess of it's MOD in the Dive Profile – this up to you to get right !

Enable: Tick this to allow automatic selection of this gas during ascent. Disabled gases may be left in the list for later use.

The Controls are:

▣   Brings up the gas popup for entry of a new gas;

 Brings up the gas popup for editing of the currently selected gas;

 Deletes the currently selected gas;

 Instructs MV-Plan to perform open circuit ascent and decompression with automatic gas selection after the last dive segment specified in the dive profile. This should be enabled for open circuit dives where decompression gases are used, or for closed circuit bailout scenarios.

Note that the order of gases in the Gas List is not important. Gas selection is based on the MOD.

Repetitive Dives

The repetitive dive panel allows you to enable repetitive dive calculations. In this mode MV-Plan maintains model data after calculating a dive profile, and re-uses this (after the specified surface interval) as the starting point for subsequent dives.

MV-Plan also allows you to Save and Load model data for later use.

Graphic 21: Repetitive Dive

Fields and Controls:

 Enables or disables repetitive mode;

Surface Interval: specifies the surface interval in minutes. Assumed to be breathing air at sea level.
Hint: If you want to perform a surface interval breathing oxygen then conduct a repetitive dive at Depth zero, Gas oxygen

 Model is clear

 Model is loaded

Also see the toolbar buttons Save and Load below.

Toolbar Buttons

The functions of the toolbar buttons are:

Calc   Calculates the dive plan;

Table   Calculates a multi-dive table with up to 5 runtimes;

Clear   Clears the model and display area;

Print   Displays a print preview of a ready-to-laminate dive plan, and

allows access to print settings;

Prefs   Opens the Preferences dialog (see below);

Load   Loads a previously saved model data file, e.g. `Dive100.xml`

Only enabled in Repetitive mode.

You can only load models that have been stored in the same measurement Units that MV-Plan is set to.

Save   Saves the current model data to a file for later use;

About   Displays the program version, registration information and Check for Updates controls (see below).

Exit   Exits the program and saves your preferences.

Preferences

The preferences dialogue allows a number of program parameters to be altered.

Graphic 22: Preferences

Field Descriptions:

Gradient Factors:

Low: low gradient factor, used for initial stop;

High: high gradient factor, used for final stop;

Gradient factors can be set from 0 (meaning ambient pressure) through to 95. See Choosing Gradient Factors above for more details.

Deco Stops:

Depth: the depth increment for deco stops in meters (1 to 10m or 3 to 33ft permitted);

Last: the last stop depth in meters (1 to 10m or 3 to 33ft permitted);

Time: the time increment for deco stops in minutes. All deco stops will be a multiple of this time (0.1 to 5 permitted);

Gas Usage:

Dive: Gas usage for the dive in litres per minute on the surface (5 to 50l/min or 0.17 to 1.77cuft/min permitted);

Deco: Gas usage during deco in litres per minute on the surface (5 to 50 or 0.17 to 1.77cuft/min permitted);

Dive Settings:

Ascent: Ascent rate. Fixed at 10m/min (33ft/min) for Buhlmann;

Descent: Descent rate in meters/min (5 to 50m/min or 16 to 165ft/min permitted);

There is no option for variable ascent and descent rates for different depths.

Altitude: Enter the altitude. Assumes that you are acclimatised to the altitude. (0 to 3000m or 0 to 9900ft permitted).

Dive plans printed with an altitude setting show the altitude on the heading:

Graphic 23: Altitude Plan

MV-Plan assumes that your depth gauge is able to produce accurate depth readings at altitude. A dive computer like a VR3 compensates for altitude to give correct readings. Cheaper or analogue depth gauges to not do this and give erroneous readings. This could cause you to dive and decompress deeper than planned and thus do insufficient decompression. A pop-up reminds you of this when ever you change the altitude from zero.

Units:

Metric: Uses meters and litres throughout.

Imperial: Uses feet and cu/ft throughout.

Deco Options:

Time is runtime: Tells MV-Plan to consider the time specified for the FIRST dive segment (not waypoint) to be runtime and not just segment time. This is common practice and includes the descent time in the bottom time.

Note that print options are now in the Print Preview window.

Extended Output: Produces a more verbose output which shows the END, M-Values, controlling compartment, and gradient factor for each stop.

```
MV-Plan 1.4
Settings: GF=15-80 Multilevel=false ppH2O=0.627 msw
===================================================
DESC: 48m for 02:23 [  2] on Trimix 21/30, SP: 1.3, END: 25m
DIVE: 48m for 17:36 [ 20] on Trimix 21/30, SP: 1.3, END: 25m
ASC : 24m for 02:23 [ 22] on Trimix 21/30, SP: 1.3, END:  6m
DECO: 24m for 00:35 [ 23] on Trimix 21/30, SP: 1.3, END:  6m M-Value: 59% [02], GF: 23%
DECO: 21m for 01:00 [ 24] on Trimix 21/30, SP: 1.3, END:  4m M-Value: 62% [02], GF: 31%
DECO: 18m for 01:00 [ 25] on Trimix 21/30, SP: 1.3, END:  2m M-Value: 66% [03], GF: 39%
DECO: 15m for 01:00 [ 26] on Trimix 21/30, SP: 1.3, END:  0m M-Value: 70% [03], GF: 48%
DECO: 12m for 01:00 [ 27] on Trimix 21/30, SP: 1.3, END:  0m M-Value: 74% [04], GF: 56%
DECO:  9m for 02:00 [ 29] on Trimix 21/30, SP: 1.3, END:  0m M-Value: 79% [04], GF: 64%
DECO:  6m for 10:00 [ 39] on Trimix 21/30, SP: 1.3, END:  0m M-Value: 83% [04], GF: 80%


Gas estimate based on Dive RMV =17.0, deco RMV =12.0L/min
Air : 0.0L
Oxygen : 0.0L
Oxygen Toxicity - OTUs: 57 CNS: 21%

WARNING: This software is experimental
and should not be relied upon for actual dives.
It probably contains errors and may get you bent.
```

Multi-Level Mode: Normally MV-Plan initialises the gradient factor to Low at the first deco stop encountered. From then on it linearly increases the gradient factor until the final stop when it is set to High.
On dives with multiple depth segments it is possible that decompression encountered during the excursion from a deep to shallower segment will initialise the gradient factors prematurely. Selecting this option keeps the gradient factor set at low until the last dive segment is executed.
Use the Extended Output display to see the effect on such dives.

About Dialog

The About Dialog shows program version and registration details, and controls program update checks:
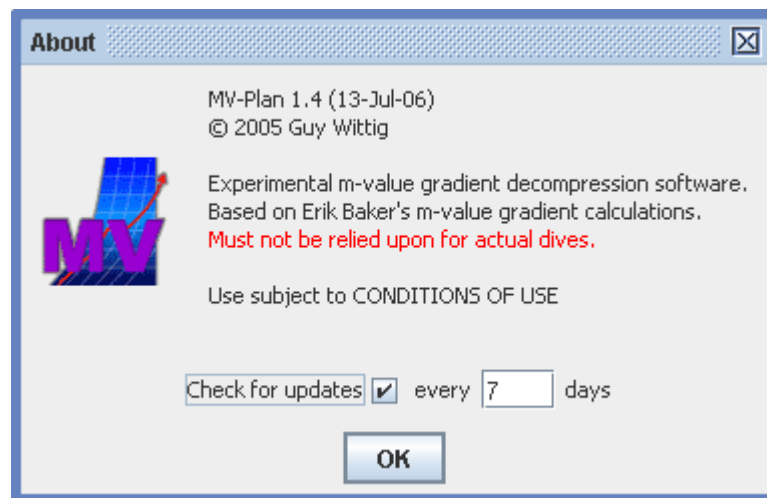
Graphic 24: About Dialog

Check for Updates: controls whether MV-Plan checks for updates. If an update is available MV-Plan will display a notification window.

Update progress is shown on the main window:

If MV-Plan determines that you have the current version, a check mark is displayed in the update progress indicator.

Clicking on the MV-Plan icon opens your browser at my web site. Follow the Diving links to the MV-Plan page.