

DYNACOMP

VALDEZ

NORTH STAR

DYNACOMP

P.O. BOX 162

WEBSTER N.Y. 14580

VALDEZC = 6645

MEMSET = 31899

STORE MAP = 3144P

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WEBSTER, N.Y. 14580

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VALDEZ - A SUPERTANKER SIMULATION
VERSION 2.0

VALDEZ is a microcomputer simulation of supertanker navigation in the Valdez region of Alaska. See the attached figure. Valdez is terminal port for the Alaskan oil pipeline. To get to Valdez harbor, supertankers must enter Prince William Sound from the North Pacific and cross that body of water to Valdez Narrows. Crossing this sound is complicated by the presence of islands, moving icebergs, and other supertankers heading for the North Pacific. Valdez Narrows itself is very treacherous as the passage is only 900 meters wide. Careful maneuvering (in the presence of tides) is required.

The program carefully simulates the above real life features of supertanker navigation in the following ways:

- 1) The movement of the supertanker under your control is simulated through equations which describe the effects of drag, inertia and engine performance.
- 2) A detailed map of the Prince William Sound area is stored bit-wise in the computer's memory. The storage is fairly efficient and covers a 256 by 256 element grid. The spacing between the grid points is 500 meters. Included on this grid are the coastline and islands as they appear on a recent Rand-McNally map.
- 3) The passage to Valdez is complicated by the presence of icebergs which originate from the Columbia Glacier. These icebergs are included in the simulation. Their motion is governed by the tides.
- 4) The tidal patterns of the Prince William Sound area are also simulated both with respect to time and position. These tides must be particularly reckoned with when entering the Narrows as there is not much room for error.
- 5) Other supertanker traffic is included. This traffic consists of several ships following a course from Valdez to the Pacific. This on-coming danger is particularly acute within the Narrows and harbor area.

Operation of the simulation is straight-forward. Most of the prompts are self-explanatory. The reader is referred to the attached annotated run listings for examples. However, to avoid confusion, a few of the responses will be discussed here. Observe that there is also an "instructions" option when running the program in the full version (17 kilobytes for the program plus 8 kilobytes for the map).

Because the map is very detailed (256 by 256), it is stored in the computer's memory in a bit-wise manner. The map is located outside the program space used by BASIC. This means that the usual practice of setting the user memory size to the maximum available must not be followed. Where this map memory space is to reside depends on the memory bound set by the user. In the North Star BASIC case, one can use the memory above BASIC by responding to "WHERE IS THE MAP TO BE STORED IN MEMORY (DECIMAL): ?" with a value one greater than the MEMSET number given earlier (see the sample run listing). For example, if the top of memory was set to 48000 via the MEMSET command, then the map storage could start at 48001. Note that the map requires 8 kilobytes of memory! The map may also be stored starting at location 0 in memory. This would use the entire region in front of the standard location of the DOS. The program runs perfectly well with the map in that location, but the DOS is affected and will not save programs properly later. However, the DOS can simply be reloaded after exercising the simulation. In summary, the user must decide on where to store the 8 kilobyte map and must be sure that the region is safe from unintentional alteration by BASIC. In general, if the program memory boundary can be set 8192 bytes lower than the maximum available, while still leaving enough space to run the program, there should be no problem.

The simulation can be run in several modes. The program will ask whether or not an open sea exercise is desired. If the answer is "Y", then a blank map will be loaded (i.e., no coastline or islands). In this mode one can practice maneuvering the supertanker. As the other ship and iceberg traffic is overlaid on this map, you can practice precision navigation in chasing and ramming other ships. This is not an easy task as the other ships are also moving, and careful navigation is required for interception. Remember, supertankers do not respond to controls quickly. Large masses

do not change direction and speed without considerable effort.

If you answer "N" to the open sea practice simulation question, there is another decision point. The next question is whether or not the Prince William Sound map should be loaded. The reason for this question is that you may have ended one round of simulation and want to start again. Because the map is still in the computer's memory, there is no reason to reload it. Note that loading the map takes some time because it is so large. If you answer "Y", the map will be loaded. If instead the answer is "N", and the VALDEZ map had not been previously loaded, then the radar display will reflect whatever random patterns there are in the reserved region of memory. This will often look like many irregularly distributed islands, and can be used as a map in itself. The objective then would be to not run aground.

If the Prince William Sound map is loaded, some realistic navigation can be performed. As the map is extensive, you can simply sail around the sound, circumnavigate islands, travel up fiords, and so on. You can also attempt the challenge of mooring at Valdez. First you have to get to the harbor. Second you have to pull up to a floating pipeline terminal located at a particular position. There are also requirements on the orientation of the tanker at final docking. These requirements are given in the "instructions" included in the full version of the program, and also listed separately.

Control of the ship is through the rudder and two engines. The rudder control is given in degrees (-45 to +45), and the engine power is given in percent. For example, full ahead would be 100(%), half reverse would be -50(%). Having two engines comes in handy in case one breaks down (which can happen!). The prompts for these controls are self-explanatory, as are the status displays. However, the radar display requires some discussion.

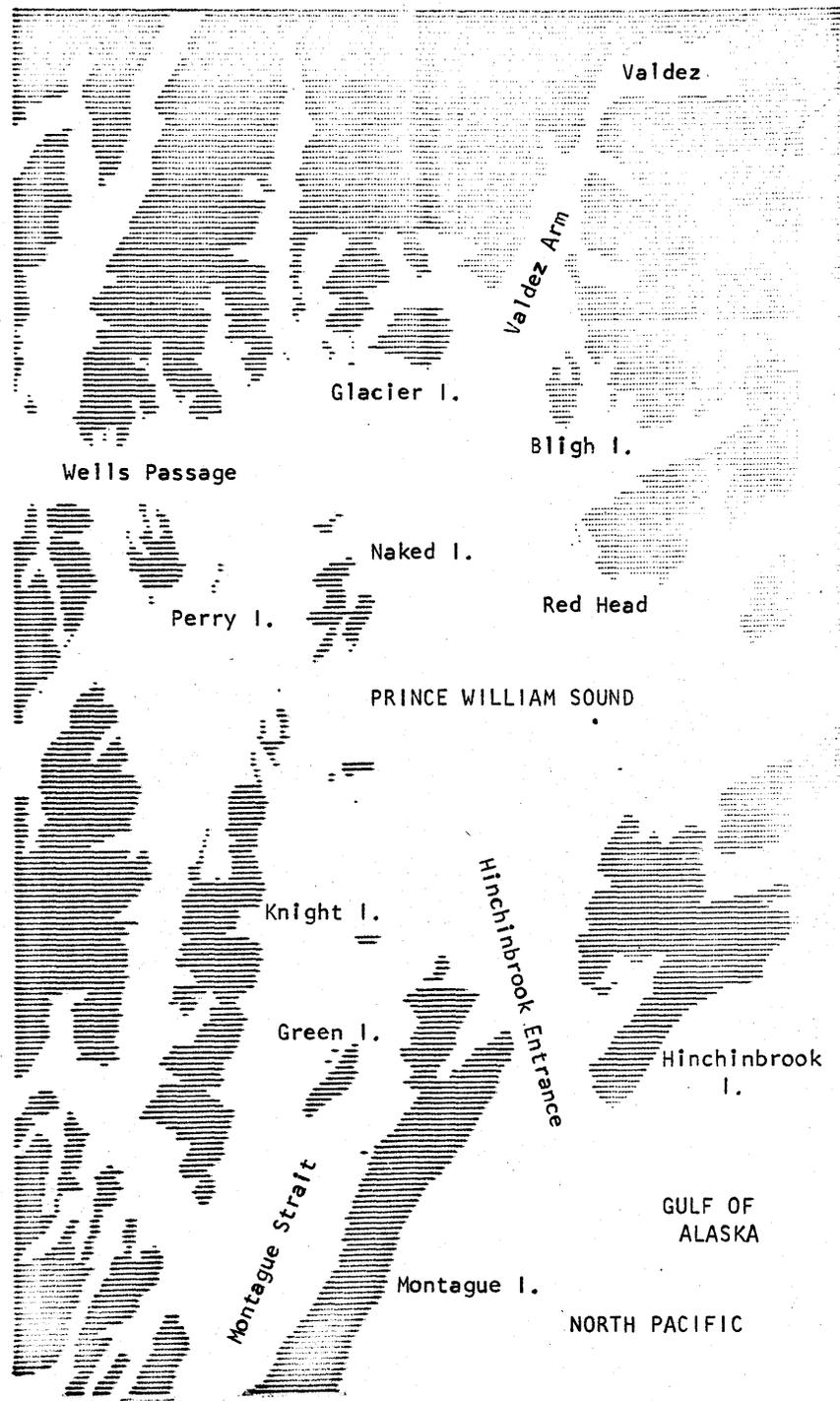
The simulation behaves as if the fog is very thick and the information is all electronic. As the Coast Guard maintains very tight monitoring of the traffic in the sound, the locations of all other traffic is known fairly accurately. However, curious as it may be, even when ships see one another, they still manage to collide. To aid the captain in avoiding collisions and skirting coasts, variable range radar is supplied. This radar has magnifications of 1x, 2x, 4x, 8x, 16x and 32x. A magnification of 1 gives the highest resolution and will show everything within range. A magnification of 32 has a coarse resolution, but will display the entire map (the region outside the map is shown as land). You will find that the various magnifications are very useful. Note that responding to the radar range factor prompt with a "0" will skip the plot. Skipping the radar display is often desirable as it takes some time to print; it is 16 by 16 grid elements, and the map must be unraveled from memory.

The display portions of the simulation were designed to be compatible with terminals having line widths of 32 or more characters. This placed a limit on the size of the radar display. For those with wider terminals, the appropriate change can be made in the FOR/NEXT loop arguments in the radar display subroutine. This might be desirable since for radar range factors larger than 1, there is a strong possibility that other ship and iceberg traffic will be missed because of the reduced resolution.

In running the simulation, most of the execution time is spent calculating the ship and iceberg movements. The motion is calculated in ten iterative steps. During periods of excitement, the delay becomes particularly apparent. However, if you consider the number of calculations performed, as well as the completeness of the simulation, the time gap is really not that great.

Additional comments:

The computer map is square and laid out in the following way. The lower left corner is designated as the origin. Its coordinates are X=0 kilometers and Y=0 kilometers. The upper right hand corner is at X=127.5 kilometers and Y=127.5 kilometers. Up is North; right is East. The supertanker starts its simulated course at X=125 kilometers, Y=0. This is very close to the lower right corner. The initial course direction is -45 degrees off North, which is Northwest. This course is in the direction of Hinchinbrook Entrance, but not exactly. Some course correction is required to accurately enter the passage. Once within the pass, a due North course is advised. This will bring the ship into the vicinity of Valdez Arm, which leads to the Narrows and thence to the port. A considerable amount of navigation is necessary to pass through the arm to the port. The final mooring coordinates are X=108 kilometers and Y=123 kilometers.



VALDEZ map as contained in the computer's memory. The actual map is square with 256 grid elements on a side. The display above was created by printing the memory contents as blanks (for "0") and asterices (for "1"). Lines of asterices give the appearance of TV raster lines, and indicate the resolution provided in the simulation.

'VALDEZ' IS A COMPUTER SIMULATION OF SUPERTANKER TRAFFIC IN THE PRINCE WILLIAM SOUND AREA OF ALASKA. THE OBJECT OF THE SIMULATION IS TO MANEUVER A LARGE SUPERTANKER THROUGH THE SOUND AND VALDEZ NARROWS TO AN OIL PIPELINE TERMINAL AT VALDEZ.

THE SIMULATION IS COMPLICATED BY SEVERAL REALISTIC PROBLEMS. FIRST, A DENSE FOG IS ASSUMED. THIS REQUIRES ALL NAVIGATION TO BE PERFORMED USING COMPASS HEADINGS AND RADAR DISPLAYS. THE RADAR DISPLAY IS MULTIPLE RANGE AND IN THE SHORT RANGE SETTING HAS A RESOLUTION OF 500 METERS. THIS RESOLUTION IS PARTICULARLY IMPORTANT IN PASSING THROUGH THE NARROWS WHERE THE LEEWAY IS ONLY 900 METERS. ANOTHER DANGER IS OTHER SEA TRAFFIC, INCLUDING BOTH SHIPS AND ICEBERGS. A CONSIDERABLE AMOUNT OF SHIPPING IS LEAVING VALDEZ HARBOR AND PASSING THROUGH THE NARROWS. THIS ONCOMING TRAFFIC MUST BE AVOIDED. THESE SHIPS FOLLOW A PARTICULAR SEA LANE, BUT THE DEPARTURES ARE RANDOM. THE ICEBERG TRAFFIC IS REALISTICALLY MORE RANDOM. THE ICEBERGS ORIGINATE AT THE TIP OF THE COLUMBIA GLACIER AND ARE SUBJECT TO THE TIDES, WHICH ARE ALSO SIMULATED. THE ICEBERGS THEREFORE MOVE SLOWLY, BUT CROSS THE SEA LANES.

TWO BASIC CONTROLS ARE AVAILABLE TO THE CAPTAIN. THEY ARE ENGINE POWER (TWO ENGINES) AND HELM (RUDDER). IT IS ASSUMED THAT A CONTROLLED HELM IS IN PLACE SO THAT ONCE THE COMMAND IS SET, IT REMAINS UNTIL INTENTIONALLY ALTERED.

THE SIMULATION IS AN EXERCISE IN PRECISION NAVIGATION. THE NAVIGATION IS RELATIVE TO A 256 X 256 GRID HAVING 500 METER SPACINGS. ALL DISTANCES ARE IN METERS. THE PORT IS LOCATED AT GRID POSITION X=108 KILOMETERS (LONGITUDE) AND Y=123 KILOMETERS (LATITUDE). FINAL MOORING IS NEXT TO A FLOATING PIPELINE TERMINAL. THE ANCHOR WILL BE DROPPED UNDER THE FOLLOWING CONDITIONS:

POSITION: WITHIN 100 METERS OF TERMINAL
HEADING: BETWEEN 80 AND 100 DEGREES OFF NORTH
SPEED: LESS THAN 0.7 KILOMETERS/HOUR

COLLIDING WITH ANOTHER SHIP OR AN ICEBERG ENDS THE SIMULATION. SO DOES RUNNING AGROUND. A COLLISION REPORT IS GIVEN DESCRIBING THE DAMAGE.

THE SIMULATION MAY BE EXERCISED IN TWO GENERAL WAYS. BY CLEARING A PATCH OF SEA WHEN GIVEN THE OPTION YOU CAN PRACTICE WIDE RANGING MANEUVERS AS WELL AS ATTEMPT TO INTERCEPT OTHER SHIPS. BY LOADING THE PRINCE WILLIAM SOUND MAP, THE FULL SIMULATION MAY BE EXERCISED.

REMEMBER, SUPERTANKERS ARE BIG AND SLUGGISH IN HANDLING. CAREFULLY PLAN YOUR COURSE!

Instructions as they are printed out when running the 25 kilobyte version of VALDEZ. The instructions option has been removed from the compressed versions.

CONTINUE?Y

ENGINE CONTROL

STATUS: PORT 75% AHEAD
STARBOARD 75% AHEAD

CONTINUE CURRENT STATUS (Y/N)?Y

- Engine power can range from -100% to +100%. Each engine can be individually controlled. It is possible for an engine to fail without warning. Also, engine damage occurs with collisions.

RUDDER CONTROL

STATUS: 0 DEGREES RUDDER

CONTINUE CURRENT STATUS (Y/N)?Y

HOW MANY MINUTES IS THIS SPEED AND HEADING TO BE MAINTAINED: ?30

- The rudder is controlled by inputting an angle. 20 degrees left rudder would be set by answering the question to the left with "N", and then responding with "20" when prompted.
- This is how long the ship will travel before a new command may be entered. It is as if the ship controls were set and the captain went for coffee.

STATUS

TIME: 9.85 HOURS

POSITION:

117.56 KM EAST
6.91 KM NORTH

WATER SPEED: 21.4 KM/HOUR

TIDE: .5 KM/HOUR SOUTH

HEADING : -45 DEGREES OFF NORTH

PORT ENGINE POWER: 75%

STARBOARD ENGINE POWER: 75%

HELM: 0 DEGREES

- Time has increased by 0.5 hours.
- The ship has moved 7.44 kilometers to the west, 6.91 kilometers to the north; a total of about ten kilometers.
- Note, the tide is changing slowly.
- Same heading as before. However, note that the heading is relative to the map and the tide causes the actual course direction to be a little different.

RADAR RANGE CONTROL

RADAR RANGE FACTOR: ?8

GRID INCREMENT: 4 KILOMETERS

- A good value for long range scanning.

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- The lower left part of Hinchinbrook Island is visible. The entrance to the sound is on the far side of this. The present course is at 45 degrees and intersects this arm. A course change will be necessary.
- Note that the supertanker has moved on the map. This can be seen relative to the map boundary.

If there were other ship traffic within the field of view of the radar, it would have one chance in sixty-four (8x8) of being displayed because of the low resolution.

CONTINUE?Y

DISPLAY OTHER TRAFFIC (Y/N): ?Y

LAST REPORTED SHIP POSITIONS

1 X= 86.3 Y= 112.8
2 X= 83.7 Y= 108.7
3 X= 79.5 Y= 67.1
4 X= 79.5 Y= 100.3
5 X= 79.5 Y= 23
6 X= 80.8 Y= 104.1

Note that this ship has moved about five kilometers to the west and about eight to the south. It is travelling down Valdez Arm.
This ship has moved nine kilometers south. It is exiting the Hinchinbrook entrance and heading into the Gulf of Alaska.

CONTINUE?Y

LAST REPORTED ICEBERG POSITIONS

1 X= 70.9 Y= 85.2

-The iceberg has moved south 0.4 kilometers.

CONTINUE?Y

STATUS

TIME: 9.37 HOURS
POSITION: 79.32 KM EAST, 74.3 KM NORTH
WATER SPEED: 19 KM/HOUR
TIDE: .5 KM/HOUR SOUTH
HEADING : 5 DEGREES OFF NORTH
PORT ENGINE POWER: 75%
STARBOARD ENGINE POWER: 75%
HELM: 5 DEGREES RIGHT RUDDER

A different example showing a collision

- Ship is located between Naked Island and Red Head; open water.
- Course almost due north. A course correction had been made recently in order to head more directly into Valdez Arm.
- Still in the process of correcting course.

RADAR RANGE CONTROL

RADAR RANGE FACTOR: ?1
GRID INCREMENT: .5 KILOMETERS

- Maximum resolution is used here as there is likely to be other shipping in the area.

Grid display showing a target marked with '0' and a '*' symbol.

- Something has appeared on the radar display. Since we know that the current supertanker location is in open water, the radar target is either another ship or an iceberg.
- According to the display, the target is ahead about 1.5 kilometers.

CONTINUE?Y

DISPLAY OTHER TRAFFIC (Y/N): ?Y

LAST REPORTED SHIP POSITIONS

1 X= 90.9 Y= 120.2
2 X= 88.3 Y= 116
3 X= 79.5 Y= 75.8
4 X= 83.2 Y= 107.9
5 X= 79.5 Y= 31.7
6 X= 85.4 Y= 111.4

This is the other ship. This is determined by comparing the position of our ship as given under "STATUS" above with the positions on this list. Ship #3 is ahead 1.5 kilometer north, 180 meters east. We are heading right for it!

CONTINUE?Y

LAST REPORTED ICEBERG POSITIONS

1 X= 71 Y= 85.6

- There is also an iceberg roughly fifteen kilometers away.

CONTINUE?Y

ENGINE CONTROL

STATUS: PORT 75% AHEAD
STARBOARD 75% AHEAD

CONTINUE CURRENT STATUS (Y/N)?Y

RUDDER CONTROL

STATUS: 5 DEGREES RIGHT RUDDER

CONTINUE CURRENT STATUS (Y/N)?Y

HOW MANY MINUTES IS THIS SPEED AND HEADING TO BE MAINTAINED: ?5

- No change. We are going to see what happens when there is a collision.

- The other ship is travelling south at 14 kilometers per hour (slow because it is loaded), and we are travelling north at 19 kilometers per hour. The impact speed will be 33 kilometers per hour and occur in less than two minutes.

COLLISION WITH SUPERTANKER!!!

MAJOR COLLISION
TAKING ON WATER
ENGINE STATUS FOR PUMPING:
PORT: 34%
STARBOARD: 0%
PUMP POWER INSUFFICIENT. SINKING.
READY

- A considerable amount of engine power has been lost; too much. The pumps can not keep up.

