

## APPENDIX A: Updated Model Equations and the Game Link

<https://unholyspace.itch.io/scuba-diving-simulator>

```
depth(t) = depth(t - dt) + (velocity1) * dt
    INIT depth = You_are_at_10_mt_but_there_is_a_disturbance_Stabilize_at_10_mt*10
    +You_are_at_20_mt_depth_Stabilize_at_10_mt*20+You_are_at_the_surface_Stabilize_at_10_mt*0
    INFLOWS: velocity1 = velocity
velocity(t) = velocity(t - dt) + (acceleration) * dt
    INIT velocity = 0
    INFLOWS: acceleration = net_force/mass
air(t) = air(t - dt) + (delayed_inflow2 - delayed_outflow2) * dt
    INIT air = pressure*(90-volume_of_the_man*1000)/RT
    INFLOWS: delayed_inflow2 = inflow_air*
    (1-(Both_Delays_05_sec_05_sec+Material_Delay_05_sec)) + delayed_inflow1 *
    (Material_Delay_05_sec+Both_Delays_05_sec_05_sec)
    OUTFLOWS: delayed_outflow2 = outflow_air*
    (1-(Material_Delay_05_sec+Both_Delays_05_sec_05_sec)) + delayed_outflow1 *
    (Material_Delay_05_sec+Both_Delays_05_sec_05_sec)+disturbance*PULSE(air/4,5,0)
into(t) = into(t - dt) + (inflow_air - delayed_inflow1) * dt
    INIT into = 0
    INFLOWS: inflow_air = if(Air_Adjustment_Decision=1)
    THEN(normal_flow*Air_Adjustment_Decision*pressure/RT)
    ELSE(0)
    OUTFLOWS: delayed_inflow1 = into/inflow_delay_time
out_to(t) = out_to(t - dt) + (outflow_air - delayed_outflow1) * dt
    INIT out_to = 0
    INFLOWS: outflow_air = IF(Air_Adjustment_Decision=-1)
    THEN(normal_flow*Air_Adjustment_Decision*(-1)*pressure/RT)
    ELSE(0)
    OUTFLOWS: delayed_outflow1 = out_to/inflow_delay_time
perceived_depth(t) = perceived_depth(t - dt) + (Noname_2) * dt
    INIT perceived_depth = You_are_at_10_mt_but_there_is_a_disturbance_Stabilize_at_10_mt*10
    +You_are_at_20_mt_depth_Stabilize_at_10_mt*20+You_are_at_the_surface_Stabilize_at_10_mt*0
    INFLOWS: Noname_2 = (depth-perceived_depth)/depth_perception_time
score(t) = score(t - dt) + (Noname_4) * dt
    INIT score = 0
    INFLOWS: Noname_4 = abs(10-depth)
Air_Adjustment_Decision = 0
Both_Delays_05_sec_05_sec = 0
cross_sectional_area = PI*radius^2
density = 1000
density_of_a_human_body = 1070
depth_perception_time = 0.5
desired_height = 10
discrepancy = desired_height-depth
disturbance = You_are_at_10_mt_but_there_is_a_disturbance_Stabilize_at_10_mt
effective_depth = IF(depth<-0.5)
    THEN(0)
    ELSE(IF(depth<0)
        THEN((0.5+depth)/2)
        ELSE(depth+0.5/2))
```

```

fin_movement = 0
flow_1 = 1
flow_3 = 0
frictional_force = 27.2*velocity^2
frictional_force_vector = IF(velocity=0)
    THEN(0)
    ELSE(-velocity/ABS(velocity)*frictional_force)
gravitational_constant = 9.81
height_of_the_man = 1.5
inflow_delay_time = 0.5
Information_Delay_05_sec = 0
lifting_force = -volume_in_water*gravitational_constant*density
lt_m3_donusumu = 1000
mass = 90
Material_Delay_05_sec = 0
minus_velocity = -velocity
net_force = (weight+lifting_force+frictional_force_vector-fin_movement*35)
normal_flow = flow_1*1+flow_3*3
No_Delay = 0
pressure = 1+effective_depth/10
radius = ((volume_m3/(PI*(height_of_the_man-1)))+radius_of_the_man^2)^(1/2)
radius_of_the_man = (mass/(height_of_the_man*denstity_of_a_human_body*PI))^(1/2)
RT = 25
volume_in_water = vol_bal_in_water+vol_man_in_water
volume_lt = air*RT/pressure
volume_m3 = volume_lt/lt_m3_donusumu
volume_of_the_man = mass/denstity_of_a_human_body
vol_bal_in_water = IF(depth<-0.5)
    THEN(0)
    ELSE(IF(depth<0)
        THEN(volume_m3*(0.5+depth)/0.5)
        ELSE(volume_m3))
vol_man_in_water = IF(depth<-1.5)
    THEN(0)
    ELSE(
        IF(depth<0)
            THEN(volume_of_the_man*(1.5+depth)/1.5)
            ELSE(volume_of_the_man))
weight = mass*gravitational_constant
Your_depth =
depth*(-1)*(1-(Information_Delay_05_sec+Both_Delays_05_sec_05_sec))+perceived_depth*(-1)*(Information
_Delay_05_sec+Both_Delays_05_sec_05_sec)
You_are_at_10_mt_but_there_is_a_disturbance_Stabilize_at_10_mt = 0
You_are_at_20_mt_depth_Stabilize_at_10_mt = 0
You_are_at_the_surface_Stabilize_at_10_mt = 1

```

## **APPENDIX B: Pre-Game Questions**

1.Name, Surname

2. If you have dived before, the number of times you have dived?

3.System Dynamics Knowledge

☐ Yes

☐ No

4.Are you familiar with pc games?

☐ Yes

☐ No

### APPENDIX C: Post-Game Questions

1. Was the objective of the task involved in the game clear?
2. Did you follow a specific strategy that you can describe? (Did your strategy differ in different versions of the game?)
3. If you had difficulties in obtaining successful results, do you think these difficulties are due to;
  - ☐ Speed of the game
  - ☐ Your weak computer/video game playing skills(as in PC or Playstation games)
  - ☐ Complexity of conceptually coming up with proper decisions, due to several interacting factors
  - ☐ Hidden/unknown difficulty factors in the game
  - ☐ Other
4. Do you find yourself successful? If not, how do you think you could improve?
5. Would any additional info increase your success in the game?
  - ☐ Depth data
  - ☐ Velocity data
  - ☐ Force data
  - ☐ Other:

### APPENDIX D: Game Results

Experimente Number	Version	Scenario	Diver	Gamer	Score
1	De	1	x		203.23
1	De	2	x		316.98
1	De	3	x		164.89
1	De	4	x		204.95
1	Du	1	x		277.49
1	Du	2	x		309.38
1	Du	3	x		83.04
1	Du	4	x		184.28
1	A	1	x		336.49
1	A	2	x		349.29
1	A	3	x		282.19
1	A	4	x		303.30
2	De	1		x	395.39
2	De	2		x	462.16
2	De	3		x	190.55
2	De	4		x	271.16
2	Du	1		x	307.62
2	Du	2		x	286.54
2	Du	3		x	57.39
2	Du	4		x	246.14
2	A	1		x	376.33
2	A	2		x	377.28

2	A	3		x	314.96
2	A	4		x	389.30

3	De	1		x	442.81
3	De	2		x	610.72
3	De	3		x	186.11
3	De	4		x	250.78
3	Du	1		x	303.74
3	Du	2		x	258.23
3	Du	3		x	65.49
3	Du	4		x	167.22
3	A	1		x	185.84
3	A	2		x	212.53
3	A	3		x	109.53
3	A	4		x	169.83
4	De	1	x		204.55
4	De	2	x		228.69
4	De	3	x		149.52
4	De	4	x		264.66
4	Du	1	x		141.68
4	Du	2	x		186.21
4	Du	3	x		67.83
4	Du	4	x		110.91
4	A	1	x		287.56
4	A	2	x		387.04

4	A	3	x		230.74
4	A	4	x		288.97
5	De	1	x	x	173.71
5	De	2	x	x	261.04
5	De	3	x	x	251.87
5	De	4	x	x	308.42
5	Du	1	x	x	126.06
5	Du	2	x	x	253.44
5	Du	3	x	x	35.83
5	Du	4	x	x	121.34
5	A	1	x	x	312.33
5	A	2	x	x	241.55
5	A	3	x	x	227.45
5	A	4	x	x	225.86
6	De	1		x	247.80
6	De	2		x	246.80
6	De	3		x	257.84
6	De	4		x	237.13
6	Du	1		x	287.66
6	Du	2		x	542.22
6	Du	3		x	308.05
6	Du	4		x	284.19
6	A	1		x	282.87
6	A	2		x	226.59
6	A	3		x	229.37

6	A	4		x	379.84
7	De	1	x	x	332.17
7	De	2	x	x	268.29
7	De	3	x	x	310.66
7	De	4	x	x	294.78
7	Du	1	x	x	390.67
7	Du	2	x	x	312.40
7	Du	3	x	x	191.52
7	Du	4	x	x	200.24
7	A	1	x	x	360.39
7	A	2	x	x	447.54
7	A	3	x	x	322.04
7	A	4	x	x	223.90
8	De	1		x	939.65
8	De	2		x	1291.84
8	De	3		x	890.52
8	De	4		x	920.05
8	Du	1		x	787.35
8	Du	2		x	1421.01
8	Du	3		x	525.63
8	Du	4		x	373.64
8	A	1		x	564.70
8	A	2		x	499.29
8	A	3		x	443.48
8	A	4		x	480.63



9	De	1		x	930.30
9	De	2		x	534.08
9	De	3		x	268.34
9	De	4		x	295.47
9	Du	1		x	374.58
9	Du	2		x	639.30
9	Du	3		x	97.72
9	Du	4		x	197.68
9	A	1		x	276.15
9	A	2		x	205.62
9	A	3		x	210.31
9	A	4		x	156.36
10	De	1	x	x	356.58
10	De	2	x	x	409.06
10	De	3	x	x	236.71
10	De	4	x	x	503.46
10	Du	1	x	x	417.78
10	Du	2	x	x	504.05
10	Du	3	x	x	203.80
10	Du	4	x	x	160.14
10	A	1	x	x	239.35
10	A	2	x	x	251.07
10	A	3	x	x	148.79
10	A	4	x	x	195.40
11	De	1	x		177.72

11	De	2	x		245.30
11	De	3	x		143.36
11	De	4	x		186.27
11	Du	1	x		222.26
11	Du	2	x		299.93
11	Du	3	x		88.42
11	Du	4	x		155.75
11	A	1	x		172.60
11	A	2	x		198.19
11	A	3	x		177.05
11	A	4	x		185.54
12	De	1	x		458.48
12	De	2	x		486.46
12	De	3	x		344.14
12	De	4	x		334.54
12	Du	1	x		270.93
12	Du	2	x		289.14
12	Du	3	x		285.80
12	Du	4	x		137.68
12	A	1	x		269.40
12	A	2	x		416.14
12	A	3	x		291.84
12	A	4	x		379.96
13	De	1			788.81
13	De	2			847.18

13	De	3			716.43
13	De	4			739.80
13	Du	1			492.55
13	Du	2			786.37
13	Du	3			643.95
13	Du	4			826.67
13	A	1			643.00
13	A	2			767.60
13	A	3			600.23
13	A	4			806.09
14	De	1			724.75
14	De	2			505.08
14	De	3			352.08
14	De	4			605.86
14	Du	1			626.86
14	Du	2			631.89
14	Du	3			589.90
14	Du	4			615.81
14	A	1			410.94
14	A	2			610.94
14	A	3			419.70
14	A	4			520.52
15	De	1	x	x	294.72
15	De	2	x	x	241.65
15	De	3	x	x	192.52

15	De	4	x	x	320.16
15	Du	1	x	x	161.79
15	Du	2	x	x	282.41
15	Du	3	x	x	45.33
15	Du	4	x	x	134.77
15	A	1	x	x	254.20
15	A	2	x	x	330.41
15	A	3	x	x	269.36
15	A	4	x	x	272.80
16	De	1		x	376.09
16	De	2		x	432.67
16	De	3		x	539.39
16	De	4		x	213.75
16	Du	1		x	372.17
16	Du	2		x	332.85
16	Du	3		x	532.28
16	Du	4		x	335.08
16	A	1		x	323.10
16	A	2		x	270.76
16	A	3		x	322.60
16	A	4		x	382.50
17	De	1			847.09
17	De	2			463.57
17	De	3			465.96
17	De	4			441.42

17	Du	1			741.93
17	Du	2			1089.48
17	Du	3			221.31
17	Du	4			778.39
17	A	1			508.52
17	A	2			323.46
17	A	3			299.14
17	A	4			1044.85
18	De	1	x	x	360.75
18	De	2	x	x	288.53
18	De	3	x	x	179.49
18	De	4	x	x	274.56
18	Du	1	x	x	263.96
18	Du	2	x	x	211.96
18	Du	3	x	x	139.30
18	Du	4	x	x	91.93
18	A	1	x	x	235.33
18	A	2	x	x	234.40
18	A	3	x	x	204.46
18	A	4	x	x	174.31
19	De	1		x	322.36
19	De	2		x	569.43
19	De	3		x	220.58
19	De	4		x	317.21
19	Du	1		x	486.71

19	Du	2		x	262.07
19	Du	3		x	225.10
19	Du	4		x	158.41
19	A	1		x	357.76
19	A	2		x	340.87
19	A	3		x	289.86
19	A	4		x	399.14

## APPENDIX E: Decision Heuristic Model Equations (VenSim)

acceleration= net force/mass  
air= INTEG (air change in BC-disturbance,  
pressure\*(90-(90/1070)\*1000)/25)  
air adjustment decision=IF THEN ELSE(desired volume > vol in water, 1, IF THEN  
ELSE(desired volume< vol in water, -1, 0))  
air change in BC= air adjustment decision\*pressure/25  
depth= INTEG (velocity 1,20)  
depth adjustment time=5  
desired acceleration= (desired velocity-velocity 1)/velocity adjustment time  
desired velocity= (10-depth)/depth adjustment time  
desired volume= -(mass\*desired acceleration-weight-friction+35\*fin movement)/9810  
disturbance= 0  
effective depth= IF THEN ELSE(depth < -0.5, 0, IF THEN ELSE(depth < 0 , (0.5+depth)/2,  
depth+0.5/2))  
fin movement= IF THEN ELSE( ABS(depth-10)< 3 , 0, IF THEN ELSE(depth < 10 , -1, 1))  
FINAL TIME = 100  
friction= IF THEN ELSE(velocity=0, 0, -velocity/ABS(velocity)\*27.2\*velocity^2)  
INITIAL TIME = 0  
lifting force= -9810\*vol in water  
mass=90  
net force= weight+lifting force+friction-35\*fin movement  
pressure= 1+effective depth/10  
TIME STEP = 0.015625  
velocity= INTEG (acceleration,0)  
velocity 1= velocity  
velocity adjustment time= 1  
vol bal in water= IF THEN ELSE(depth < -0.5, 0, IF THEN ELSE(depth<0 ,  
((air\*25/pressure)/1000)\*(1+depth/0.5), ((air\*25/pressure)/1000)))  
vol in water= vol bal in water+vol man in water  
vol man in water= IF THEN ELSE(depth < -1.5, 0, IF THEN ELSE(depth < 0 ,  
(90/1070)\*(1+depth/1.5), 90/1070))  
weight=9.81\*mass