Capstone Log

Conrad Mearns

Minutes - Friday, Febraury 21st, 2020

2:00pm - 3:10pm

Meeting participants:

Conrad Mearns, Joshua Dempsey

Ammendments to previous Minutes

None

Agenda Items

Contract

Actions taken - Drafted team contract

Next steps

- Conrad to finalize contract prose for final draft
- Damon to edit contract draft in lieu of absence
- Contract to be sent to Bolden

No Votes

No Motions

No items held over

New business

- Sign final draft of the contract
- Review previous team's project resources

Next meeting - Fri 26, 2pm, Library

personal notes

So far it looks like things are going well. I'm curious as to what exactly we'll be doing.

Thursday, February 27, 2020

I'm not really sure what to be writing about, what to be researching. I guess this is just a diary? Dear Diary: I wish there was some inkling of direction to take here. I can research and write until my fingers blead but it does nothing for the project, or for the client.

Minutes - Tuesday, March 3rd, 2020

3:39pm -

Meeting participants:

Conrad Mearns, Joshua Dempsey, Damon Schafer

Ammendments to previous Minutes

None

Agenda Items

Sign final draft of the contract

Name decision - Dev's Dev's

No Votes

No Motions

No items held over

- Review previous team's project resources

New business

- Wikipedia / Knowledgebase
- Review Farming Simulator Terrain API

Next meeting - Tue 10, 3:30pm, One World

personal notes

It seems like we're getting a little more disorganized. It's hard to keep this work prioritized when we don't know what to really fcus on though, and besides, I need to figure out what I'm doing for CAPS Idaho - ironic though, both projects lack direction.

#Sunday, March 15, 2020 Dev wants us to firstly - fix the GIS data in Farming Simulator, and also work on algorithms for controlling tractor movements based on optimizations for time, and soil erosion. I'm not as interested in the more general pathfinding algorithms - I'm more interested in what the soil erosion algorithms look like.

In general, the question is how can we create an self driving (or assisted) tractor that not only covers the area that it needs to cover, but also prevents soil erosion? This comes with the context that the if the tractor drives on the same path many times over and over again, the soil will erode. What does this really mean though? Could we simply plot a naive course in which a tractor just varies it's course by plus or minus the width of it's tires?

What do human farmers look for when driving to avoid tractor-based erosion?

Are there tools that could help us model soil erosion already?

Wednesday, March 25, 2020

I decided that the best thing to do would be to try and do some research every once and a while. This is an article I read between my other projects this week. I just need to remeber to keep researching from time to time.

https://www.hindawi.com/journals/tswj/2014/404059/

Very interesting paper, effectively covers the network architecture for self driving tractors (RHEA system).

Does not cover anything on erosion - but from this we may be able to consider the full potential of percision movements - how much control do developers have over concerns of track-erosion?

Abstract

Computer-based sensors and actuators such as global positioning systems, machine vision, and laser-based sensors have progressively been incorporated into mobile robots with the aim of configuring autonomous systems capable of shifting operator activities in agricultural tasks. However, the incorporation of many electronic systems into a robot impairs its reliability and increases its cost. Hardware minimization, as well as software minimization and ease of integration, is essential to obtain feasible robotic systems. A step forward in the application of automatic equipment in agriculture is the use of fleets of robots, in which a number of specialized robots collaborate to accomplish one or several agricultural tasks. This paper strives to develop a system architecture for both individual

robots and robots working in fleets to improve reliability, decrease complexity and costs, and permit the integration of software from different developers. Several solutions are studied, from a fully distributed to a whole integrated architecture in which a central computer runs all processes. This work also studies diverse topologies for controlling fleets of robots and advances other prospective topologies. The architecture presented in this paper is being successfully applied in the RHEA fleet, which comprises three ground mobile units based on a commercial tractor chassis.

Thursday, March 26, 2020 - Soil Erosion Simulation / Study Tool

Sounds like it effectively meets (most) of the requirements of our client - granted it's not a VR simualtion, but it covers education of the USLE equation and how to effectively make decisions using such a model.

https://www.tandfonline.com/doi/abs/10.1080/00958964.1987.9942736

Abstract

The need for education and understanding about the continuing soil erosion problem is acute. Most segments of the population have little knowledge of the critical impacts erosion can have on the environment. The use of the Soil Conservation Service model for erosion determination, the Universal Soil Loss Equation (USLE), is a good perceptual tool to show the impacts of human and natural action on the land. Micro-DYNAMO, a special-purpose computer simulation language, was programmed to simulate the USLE under several different environmental and farming practice scenarios. This type of simulation will never duplicate nature but will allow natural processes to be evaluated and this information to be used for rational decision making and understanding.

Friday, March 27, 2020 - Effects of Tractor Passes - Erosion

Effects of Tractor Passes on Hydrological and Soil Erosion Processes in Tilled and Grassed Vineyards https://www.mdpi.com/2073-4441/11/10/2118

A very well written paper on how multiple tractor passes create ruts in which rainfall mainly causes damage. Covers soil penetration resistance based on density, based on dry/wet seasons.

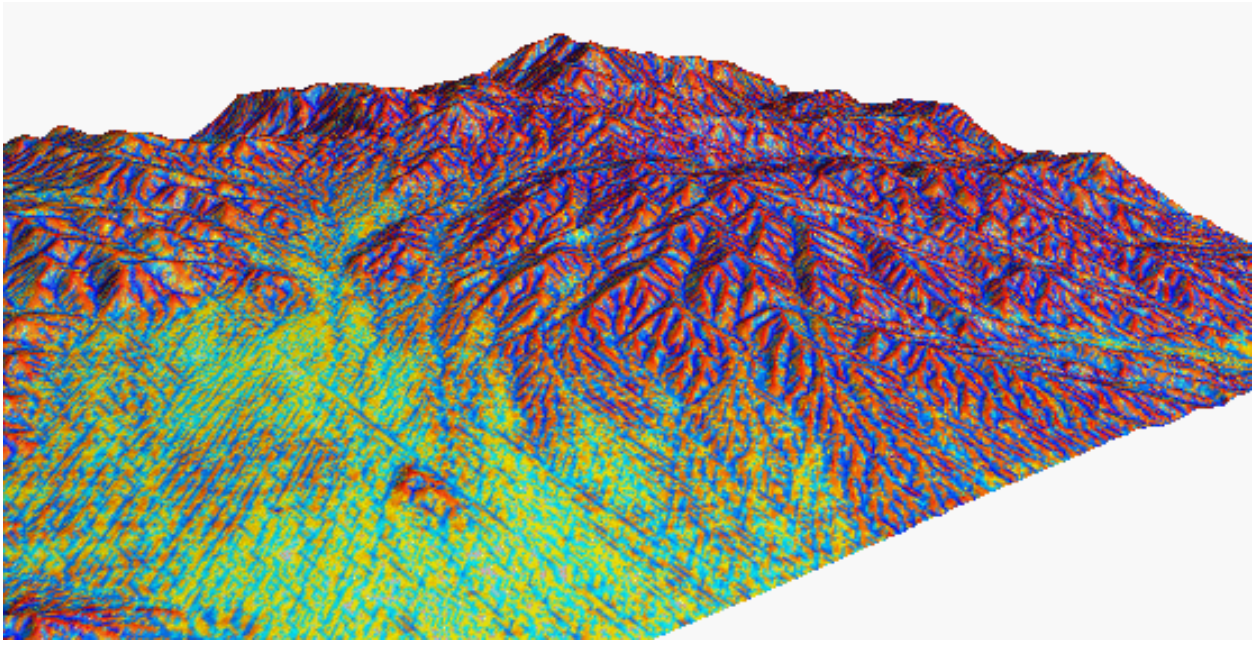
Abstract

Soil erosion is affected by rainfall temporal patterns and intensity variability. In vineyards, machine traffic is implemented with particular intensity from late spring to harvest, and it is responsible for soil compaction, which likely affects soil hydraulic properties, runoff, and soil erosion. Additionally, the hydraulic and physical properties of soil are highly influenced by vineyards' inter-rows soil management. The effects on soil compaction and both hydrological and erosional processes of machine traffic were investigated on a sloping vineyard with different inter-row soil managements (tillage and permanent grass cover) in the Alto Monferrato area (Piedmont, NW Italy). During the investigation (November 2016–October 2018), soil water content, rainfall, runoff, and soil erosion were continuously monitored. Field-saturated hydraulic conductivity, soil penetration resistance, and bulk density were recorded periodically in portions of inter-rows affected and not affected by the machine traffic. Very different yearly precipitation characterized the observed period, leading to higher bulk density and lower infiltration rates in the wetter year, especially in the tilled vineyard, whereas soil penetration resistance was generally higher in the grassed plot and in drier conditions. In the wet year, management with grass cover considerably reduced runoff (76%) and soil loss (83%) compared to tillage and in the dry season. Those results highlight the need to limit the tractor traffic, in order to reduce negative effects due to soil compaction, especially in tilled inter-rows.

DEM resolution, topographic analysis, and erosion modeling

http://fatra.cnr.ncsu.edu/~hmitaso/gmslab/protected/irwin/irwin1.html

Ongoing research into modelling large scale (3000 sq miles!) erosion grids.



Really cool sim outputs, but no further context on how this all comes together (that I could find). I appears as though this only offers images of simulation output.

I'll need to look for more simulations.

Wednesday, April 1, 2020 - Building compound models for surface processes

https://www.agu.org/Events/SCIWS8-Exploring-Surface-Processes-how-to-build-coupled-models

Looks like this article could be valuable - the Community Surface Dynamics Modeling System is an NSF funded initiative for software analysis on surface processes. Over 200 models, tools, and cyberinf.

It appears the tooling is primarly built in Python, and includes multiple tutorials and jupyter notebooks to get users started. It costs $150 ($75 for students)

https://www.agu.org/Events/SCIWS8-Exploring-Surface-Processes-how-to-build-coupled-models

Ah, actually it's a workshop, not strictly an article.

Thursday, April 9, 2020 - Fast Hydraulic Erosion Simulation - GPU

http://www-ljk.imag.fr/Publications/Basilic/com.lmc.publi.PUBLI_Inproceedings@117681e94b6_fff75c/FastErosion_PG07.pdf

Provides methods, equations, and algorithms for 3D celluar erosion simulation. Alone, I don't think is too helpful - however if the methods described here were paired with soil compaction algrotihms, then we could effectively simulate would long-term tractor compaction would do to the terrain.

What do underground root structures do to the soil compaction? I would imagine this is different between crops - vineyards vs wheat for instance.

Abstract

Natural mountains and valleys are gradually eroded byrainfall and river flows. Physically-based modeling of thiscomplex phenomenon is a major concern in producing re-alistic synthesized terrains. However, despite some recentimprovements, existing algorithms are still computationallyexpensive, leading to a time-consuming process fairly im-practical for terrain designers and 3D artists.In this paper, we present a new method to model the hy-draulic erosion phenomenon which runs at interactive rateson today's computers.

The method is based on the velocityfield of the running water, which is created with an efficientshallow-water fluid model. The velocity field is used to cal-culate the erosion and deposition process, and the sedimenttransportation process. The method has been carefully de-signed to be implemented totally on GPU, and thus takesfull advantage of the parallelism of current graphics hard-ware. Results from experiments demonstrate that the pro-posed method is effective and efficient. It can create realis-tic erosion effects by rainfall and river flows, and producefast simulation results for terrains with large sizes.

Friday, April 10, 2020 - Estimating erosion from GIS data

https://www.jswconline.org/content/58/3/128

This would pair nicely with the simulation techniques I found earlier - we could collect data on our local area to show specifically what the erosion would look like for Moscow vs say, SoCal.

Seeing as we alreayd have to dig into GIS data techniques, this would be worth spending a week or 2 on.

Abstract

A comprehensive methodology that integrates erosion models, Geographic Information System (GIS) techniques, and a sediment delivery concept for estimating water erosion and sediment delivery at the watershed scale was presented. The method was applied to a typical agricultural watershed in the state of Idaho, which is subject to increasing soil erosion and flooding problems. The Revised Universal Soil Loss Equation (RUSLE) was used to assess mean annual water erosion. The Sediment Delivery Distributed (SEDD) model was adapted to determine sediment transport to perennial streams. The spatial pattern of annual soil erosion and sediment yield was obtained by integrating RUSLE, SEDD, and a raster GIS (ArcView). Required GIS data layers included precipitation, soil characteristics, elevation, and land use. Current cropping and management practices and selected, feasible, future management practices were evaluated to determine their effects on average annual soil loss. Substantial reduction in water erosion can be achieved when future conservation support practices are applied. The integrated approach allows for relatively easy, fast, and cost-effective estimation of spatially distributed soil erosion and sediment delivery. It thus provides a useful and efficient tool for predicting long-term water erosion potential and assessing erosion impacts of various cropping systems and conservation support practices.

Saturday, April 18, 2020 - LandLab

https://www.hatarilabs.com/ih-en/modeling-of-soil-erosion-with-landlab-in-python-free-software

Open source python based land / erosion modelling tool! I love it when my work is already 50% complete.

Will need to examine how fine the siulation can be set to for this tool set, I would imagine that we need to be fairly percise if we are trying to describe the effects of pathing on soil (this toolset can model volcanic and glacial activity - which is obviosuly a couple magnitudes larger in scale.)

From site

Landlab is a model environment based in Python for the numerical model of landscape models. The software is designed for scientific fields and calculates the dynamics of earth surface such as geomorphology, hydrology, glaciology, stratigraphy and others related.

Landlab components can calculate fluxes like water, sediments, glaciers, volcanic material and landslides. This calculus is made through terrain grids.

Landlab is open source and has been designed to accelerate the development of models providing tools to generate grids, components of interoperable processes and tools for input, output and represent data.

https://landlab.github.io/#/

Thoughts

I think we could create algorithms based on this - depending on the speed of erosion simulations.

Actually, what we could do is maybe train machine learning algs, have each one drive a plot, record the pathing, update LandLab terrain, and then preform a simulation for X years on the effected terrain.

This might cause my computer to light on fire, but that would be worth it. I wonder if anyone else has done machine learning and pathfinding like this? I would assume so, very similar problem scope to self driving cars.

Saturday, April 25, 2020 - pyBadlands

More python land simualtion stuff - this appears to be more directed at oceanic modelling

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5896951/

Abstract

Understanding Earth surface responses in terms of sediment dynamics to climatic variability and tectonics forcing is hindered by limited ability of current models to simulate

long-term evolution of sediment transfer and associated morphological changes. This paper presents pyBadlands, an open-source python-based framework which computes over geological time (1) sediment transport from landmasses to coasts, (2) reworking of marine sediments by longshore currents and (3) development of coral reef systems. pyBadlands is cross-platform, distributed under the GPLv3 license and available on GitHub (http://github.com/badlands-model). Here, we describe the underlying physical assumptions behind the simulated processes and the main options already available in the numerical framework. Along with the source code, a list of hands-on examples is provided that illustrates the model capabilities. In addition, pre and post-processing classes have been built and are accessible as a companion toolbox which comprises a series of workflows to efficiently build, quantify and explore simulation input and output files. While the framework has been primarily designed for research, its simplicity of use and portability makes it a great tool for teaching purposes.

Tuesday, April 28, 2020 - Contour Planning

https://www.researchgate.net/publication/235984970_Contour_Planting_A_Strategy_to_Reduce_Soil_Er

Again, it appears a lot of work has already been done! This paper outlines GPS guided tilling machines and contour planning to reduce soil erosion on steep slopes. This is *exactly* what our client is looking for.

This also captures some nice statistical elements - such as planning and modelling for 100 year storms.

Abstract

Practices that combine GPS-based guidance for terrain contouring and tillage for runoff detention have potential to increase water infiltration and reduce runoff. The objective of this study was to investigate contour planting as a means to reduce soil erosion on steep slopes of the Columbia Plateau dryland wheat region. An exploratory field study was conducted on a Ritzville silt loam (coarsesilty, mixed, superactive, mesic Calcidic Haploxerolls) and 0-20 percent slopes. Planting was performed with a deep furrow drill on the contour to a depth of 20 cm. Our results demonsrate that a strip of deep-furrow seeding precisely contoured on the upper shoulder slope should provide sufficient detention storage to capture and hold the runoff from a 100-yr 24-h storm if the contour strip area was approximately 2 % of the runoff collection area. This research also examined artificial neural networks for generating routing maps that optimize seeding on precise, GPS-guided contours. A contouring algorithm was evaluated in which the direction of a tractor is determined by contour-based neural activity whereby neurons corresponding to regions of the terrain of similar height to that of the tractor's current position receive the greatest excitatory input. The contour region, therefore, has the global effect of influencing the whole state space to attract the tractor in the right direction. Keywords: contour planting, soil erosion, artificial neural networks

Deeper dive - Wednesday, April 29, 2020

Cf Torisu et al. (2002), Ashraf et al. (2003), Zhu et al. (2005) All used ANN for incline, slipage, velocity, rate-of-steering control

> A discrete 2-D surface of a DEM forms the structure for the ANN (Fig. 2). Lateral connections between neurons become adjacent connections to neighboring cells

How do they model erosion though?

> Further research is needed to evaluate the effectiveness of precision contouring with a deep furrow drill in providing resistance to water erosion.

Ah, voodoo. They discuss a few equations used, but overall don't provide enough content to make the study reproducible.

> A field study was conducted in a farm field near Echo, Oregon on and above the shoulder position of a 30% hill slope. The climate is semiarid with average annual precipitation of 280 mm (11-in) with most falling October through March. Soils are derived from loess parent material and are classified as Ritzville silt loam (coarse silty, mixed, superactive, mesic Calcidic Haploxerolls). The field has been in a summer fallow-winter wheat rotation where the primary tillage consists of disking or chiseling, followed by cultivation and rodweeding operations. The study was conducted in the fallow phase of the rotation.

There is a lot more information here than I would have expected based on conversations with our client.

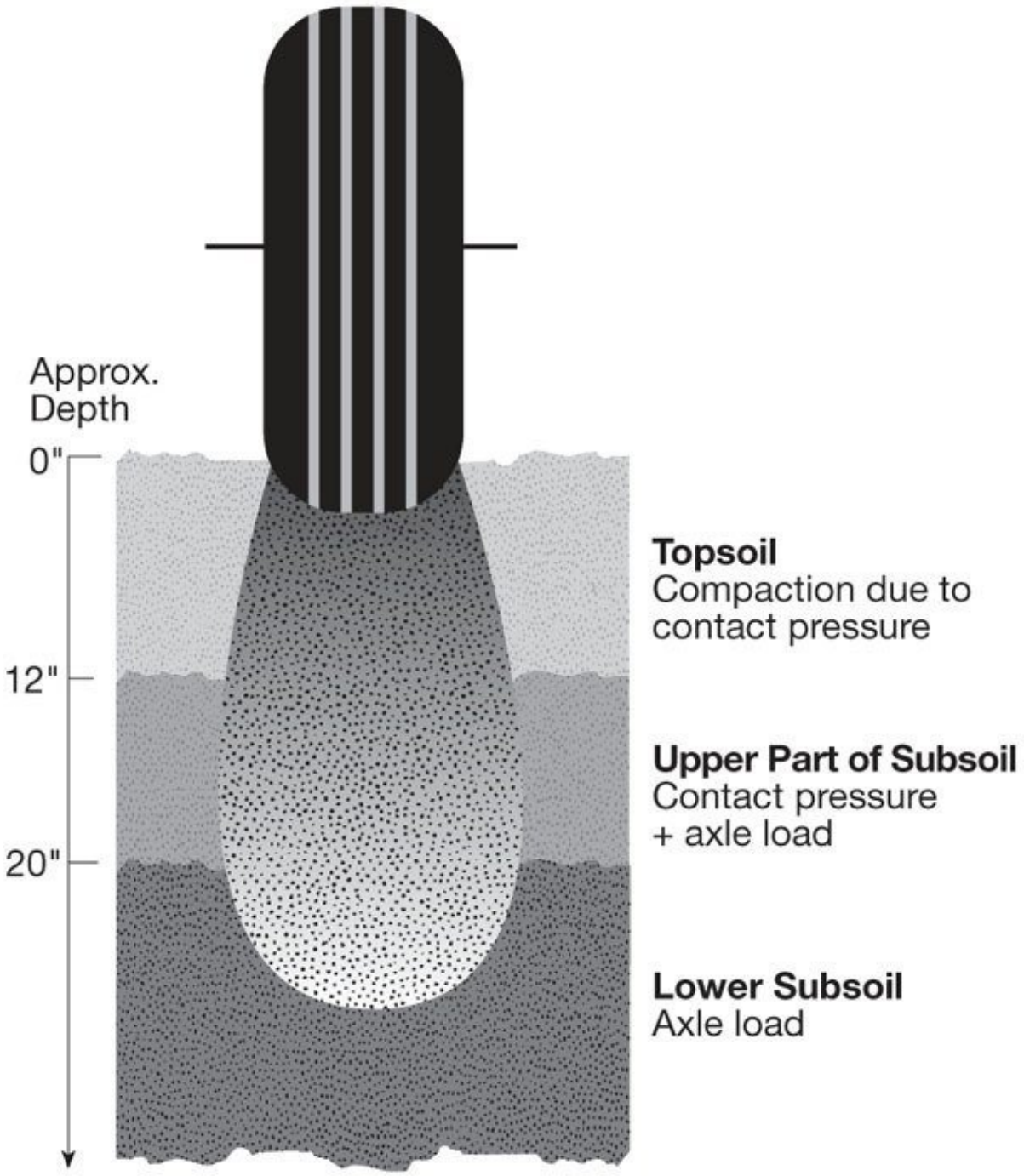
Some questions

Is this model robust enough to be translated to other climates and terrains? How effectively does it determine erosion potential? How do you effectively measure contour accuracy against erosion potential? What ANN architecture did they create? They mention how ANN's work but thats kind of insulting to be honest... Cf past Cfs on older ANN archs.

It may be more effective to pair an ANN with a reward based network - in any case I'm sure there is a lot of literature on self driving cars that this paper had no access to (published in 2010, it's been a while!)

Thursday, May 7, 2020 - Avoiding Soil Compaction

https://extension.psu.edu/avoiding-soil-compaction



Do the simulations in previously found models account for varying layers of soil compatcion? How do they model soil? Does it even matter?

> (1) surface tillage (moldboard plowing in most experiments) did not completely alleviate surface compaction and (2) deep penetration of frost did not alleviate lower subsoil compaction (most experiments were located in northern latitudes where soil is commonly frozen to 40-50 inches in winter).

This described a lot of very interesting ways to avoid compaction in depth - by creating

a ‘hardpan’ layer of soil, compaction in lower subsoil layers can be reducued - as well as simply making the tire load lighter.

Do previous simulations account for tractor / tire load? I would hope so, it’s an important factor in slipage. . .

There is also an analysis on the plasticity of soil at the end of this paper which links the soil water content and soil denstity to compressibility.

Intro

Twenty-first-century farm economics stimulate farmers to increase the size of their operations. To improve labor efficiency, farm equipment usually increases in size. Tractors, combines, forage harvesters, grain and forage wagons, manure spreaders, and lime trucks are all bigger than they used to be. Twenty years ago, for example, 2.5-ton box-type manure spreaders were common in Pennsylvania, whereas today liquid manure spreaders may weigh 20 or 30 tons. The increasing size of farm equipment may cause significant soil compaction that can negatively affect soil productivity as well as environmental quality.

Semester Two

August

I began the semester with this email to Bolden,

> Greetings Bruce,
>
> I am responding on behalf of the Cyber Farming Group - Joshua Dempsey, Damon Schafer, and myself.Last semester, we focused on researching tools, algorithms, and methods that may be useful in completing our client’s tasks. Simulating soil erosion caused by heavy equipment usage, modding Farming Simulator 14 to support a better VR experience, and interpolating GIS map information are our three core areas of work to complete. We have multiple solid leads for beginning soil erosion calculations in Python, which will require follow on tasks to interface with Farming Simulator. We are in the process of discussing the implications of COVID-19 on our work - which may affect the VR task and remote work opportunities.
>
> We look forward to meeting with you next Tuesday to discuss the future of the project, Conrad Mearns and the Cyber Farming Team

The team has set up some times for meetings, and we've started communicating with Dev to figure out what materials we need.

- VR Equipment
- Lab Access
- Copy of Farming Simulator

I think there's extra software needed to connect the VR headset to Farming Simulator? Should be in my notes somewhere. Hopefully the Farming Simulator doesn't need a new key. . .

#9-1

We have a meeting with Bolden today to go over the course and expectations, so that'll be good.

3 people showed up to the metting, Bolden was not one of them. I emailed Bolden about it and he sent me a reply as I was leaving Campus.

Kinda upset about that, I would have preferred a remote meeting anyway due to COVID but. . .

10pm - got word that Dev can hand off Farming Simulator and the hardware. I'll pick that up tomorrow.

#9-2

Oh! We're using Farming Simulator 19, not 14, that's good. The documentation for Farming Simulator 14 looked very sparse, so I'm feeling much better about working with a modern edition.

The Disc includes an activation key and I'm not sure if it'll work. . . I don't have a DVD drive in my laptop anyway. We also have no way to share the disc because of the pandemic. . .

#9-3

We decided to order the game on Steam and share the account. Here is the credential information - it's attached to my University Email but I'll give that information to Dev so that we can transfer the account over to him.

```
Username: CyberFarmerDev
Password: SJ9thZA8XgQHXAf555
```

Farming Simulator Order Details

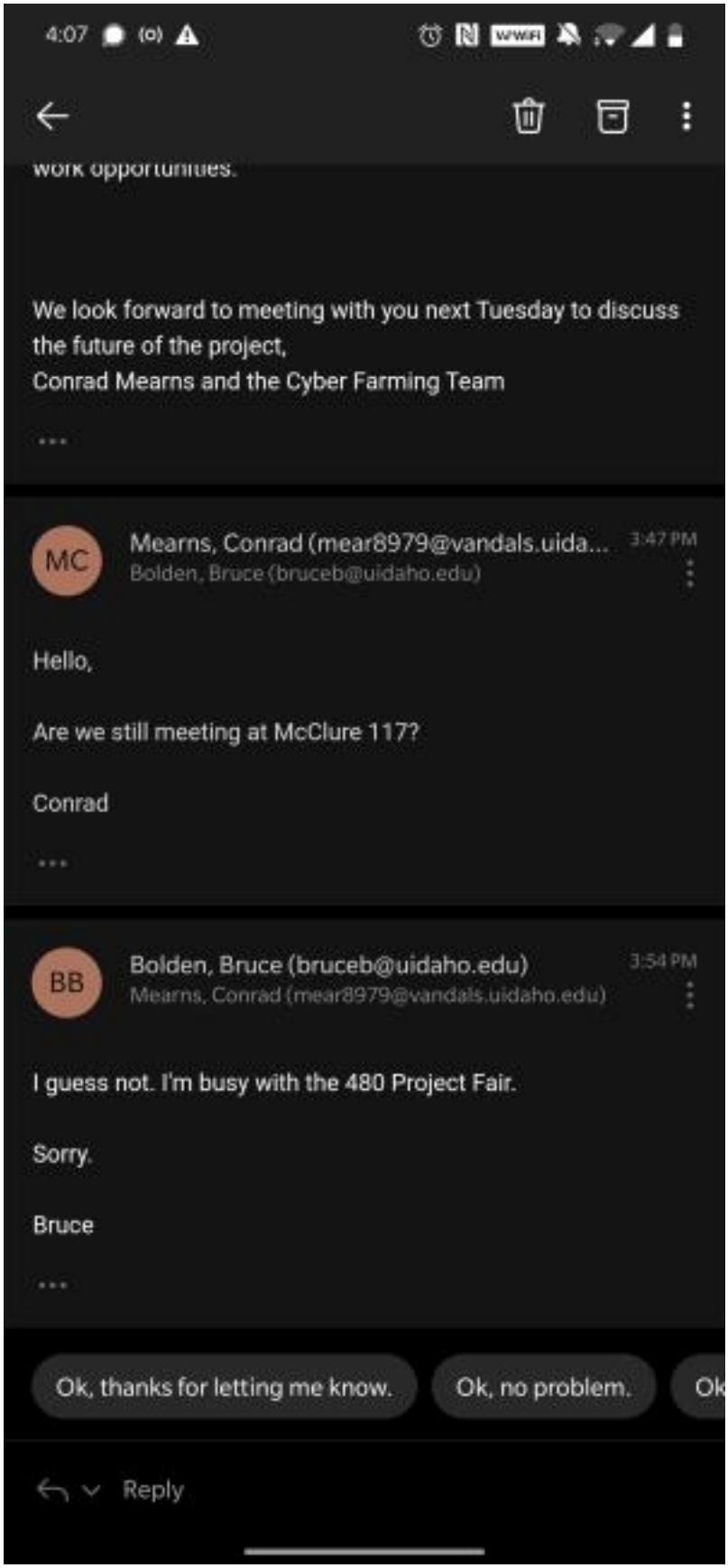


Figure 1: September 1 Meeting Email

```
Account Name
cyberfarmerdev
Total
$26.49
Confirmation code
2610354436656904135
```

Now I just need to figure out how to get it to run on Linux...

Okay, so on NixOS the process wasn't too bad. I needed to get my graphics drivers updated (using an NVIDIA GTX1060) and then it was just a matter of adding steam to my configuration.nix. In the advanced settings for Steam, I enabled Proton and launched FS through it. Looks like everything works! And ti doesn't lag at all, super cool.

#9-8

There's some kind of snapshot day we need to prepare for it seems? Not sure exactly what we need to do, but Damon has emailed Bolden to figure that out.

Some things we need to focus on: - make an arbitrary custom map in the Giants editor - make the GIS based map - determine risk for soil erosion simulation in Lua vs creating a Python Soil Server

I'm not even sure that we can paint terrain or change map vertex information in Farming Simulator... Will have to come back to that.

#9-15

The meeting today went well, we planned out a lot of work to be done. There's still so much that needs to be researched but it looks like it will all be doable.

I'm taking on getting a "Hello World" mod running in Farming Simulator. I don't know how to start this yet, the disc Dev gave me won't work on my PC *and* I'm running NixOS...

We've emailed Bolden about the Snapshots so that we can start preparing for them.

9-22

Getting Farming Simulator's GIANT's editor set up on Linux wasn't too bad either. Everything seems to run fine through Wine and on NixOS the setup is still just as easy. Running FS through Steam requires proton (im using 5.0.9) but this is also trivial to set up if you know where the advanced settings are.

You have to edit `./.local/share/Steam/steamapps/compatdata/787860/pfx/drive_c/users/steamuse` `Documents/My Games/FarmingSimulator2019/game.xml` to enable developer controls.

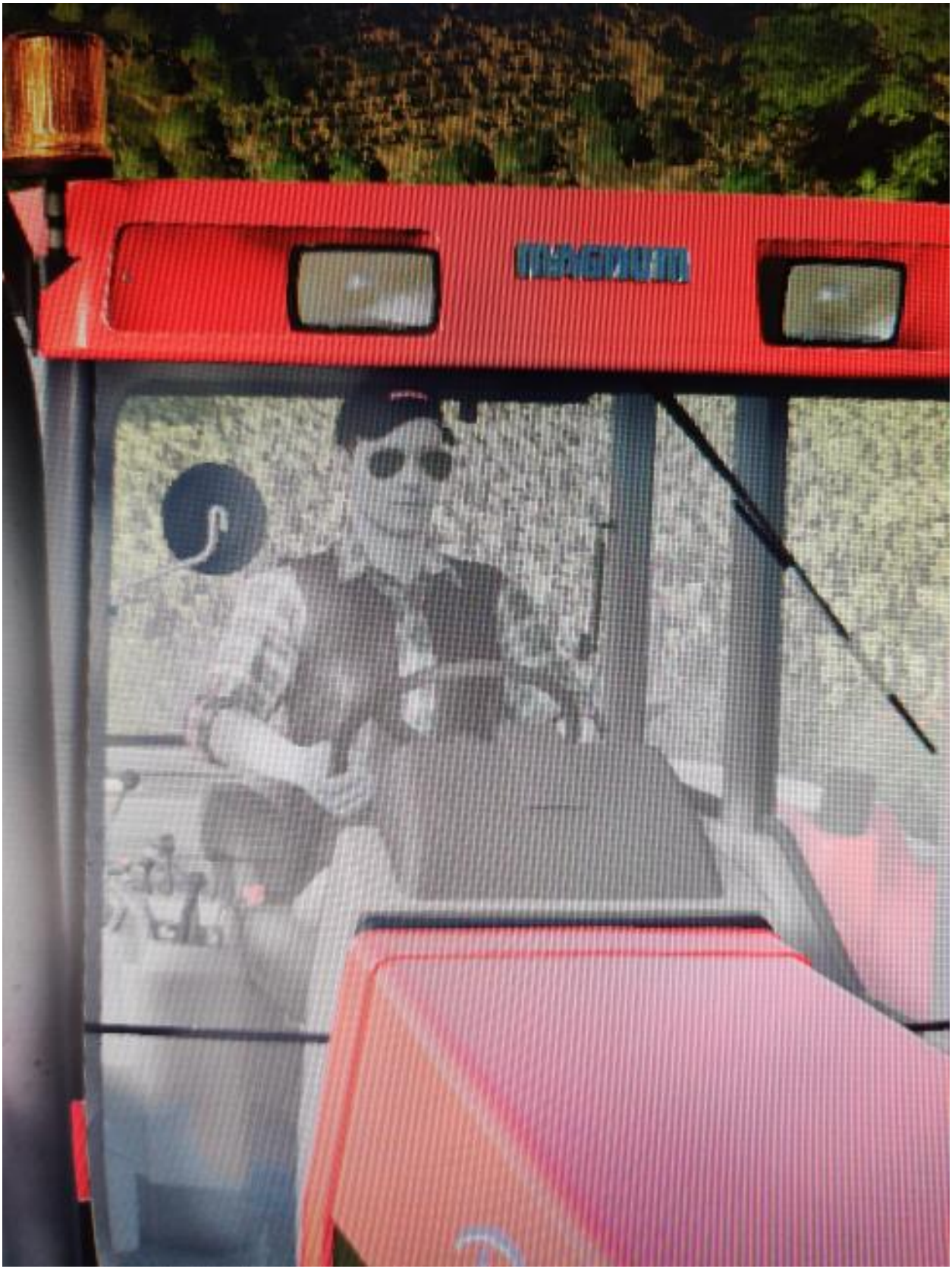


Figure 2: Farming Simulator Running through Proton on NixOS

This is probably different on other machines because I'm using NixOS.

Mod information has to be placed in

`/home/conrad/.local/share/Steam/steamapps/compatdata/787860/pfx/drive_c/users/steamuser/Documents/My Games/FarmingSimulator2019`

I've created a makefile that copies the Lua modules and XML data into the mod folder as a zip.

My mod got loaded but I wasn't able to see proof of my lua script executing. How do I test this? If I put 3rd party mods into this folder they work... Mine doesn't...

9-29

This documentation is terrible... The most descriptive item about console commands that I've found was here: https://gdn.giants-software.com/thread.php?categoryId=22&threadId=8514

But I got the mod working! I'll need to do a writeup and explain how to replicate this, but it's not too difficult. It's just nearly impossible to find a good source of information.

In order to support future work with preforming more intensive simulations (like soil erosion + also to allow developers to build tools in ANYTHING not just lua), I'll work on finding a way to "call out" of Farming Simulator into some other API, REST would be helpful.

#10-16

I now know that we are using Lua 5.1 which is sandboxed. Shit.

Here's some code I've been testing.

```lua
-- get the version
print(_VERSION)

-- test default library facilities
print(math.sqrt(64))

-- testing string->code
f = loadstring("i = i + 1")
i = 10
print(i)
f()
print(i)
-- this outputs 10, then 11. success!

-- https://apocrypha.numin.it/talks/lua_bytecode_exploitation.pdf
```

```
-- maybe we can break lua?
-- this causes the module not to compile...
print(=tostring(string.upper))


-- we may be able to call load file, but Im not sure what the path would be...
g = loadfile("./small.lua")
g()
g("hello!")

-- small.lua is
-- function foo (x)
--     print(x)
-- end

-- This should load the file and save it as callable, output should be "Hello!"

-- This all fails though...

-- Aha, we can't open files
-- we cannot call io.open with "r"
print(io.open("cyberxxx", "r"))

-- But we can call io.open with "w"
local c = assert(io.open("cyberxxx", "w"))
c:write("hello!")
assert(c:close())
-- did this work? I cant remember. I think failure is the only thing that happened
-- it worked! as if thats helpful tho
-- well, maybe if we write code into FS, we can save the info to file as to preserving

-- There's no way to access file or network IO though... which means we won't be able to
```

This basically makes all of the research I've done last semester useless. Kind of panicking now, maybe we can hack it?

5.1 escape https://gist.github.com/corsix/6575486

5.2 escape https://github.com/erezto/lua-sandbox-escape

seems to get close

10-14

I cannot, for the life of me, get these hacks to work.

The 5.2 won't work obviously... because FS 2019 uses Lua 5.1, but luckily I found that 5.1 hack as well. The other thing though, is that this shit is so old it only works on 32x systems.

I've been trying to pull the code apart and understand it so that I can update it, but I've been struggling to work on this and stay caught up in Compilers and Theory of Computation.

I can probably spend some extra time on this though.

AHhh this is going to take so much time.

```
if string.dump(function()end):sub(1, 12) ~= "\27Lua\81\0\1\4\4\4\8\0" then
  error("This generator requires a 32-bit version of Lua 5.1")
end
```

I can get rid of this check to get the exploit started, but I don't know enough about the Lua VM to actually correct any of the following code.

This is pretty cool stuff though, notice that instead of asking for version or OS information, it just compares the byte-literal of an empty function.

However, this is what I get...

```
print(string.dump(function()end):sub(1, 12))
>uaR
```

I need to compare bytes, so instead let's convert

```
s = string.dump(function()end):sub(1, 12)
length = string.len(s)
for i=0,length,1 do print(string.byte(s, i)) end
>27
>76
>117
>97
>82
>0
>1
>4
>8
>4
>8
>0
```

```
\27     >   27
L       >   76
u       >   117
a       >   97
\81     >   82  // interpreter is Lua 5.2, not 5.1, this is okay
\0      >   0
\1      >   1
```

```
\4      >   4
\4      >   8   // Idk what this means, but this is why the check fails
\4      >   4
\8      >   8
\0      >   0
```

What I need to do next, is fix this function to work on x86

```lua
local function f2ii(x) -- Convert double to uint32_t[2]
    if x == 0 then return 0, 0 end
    if x < 0 then x = -x end

    local e_lo, e_hi, e, m = -1075, 1023
    while true do
    e = (e_lo + e_hi)
    e = (e - (e % 2)) / 2
    m = x / 2^e
    if m < 0.5 then e_hi = e elseif 1 <= m then e_lo = e else break end
    end

    if e+1023 <= 1 then
    m = m * 2^(e+1074)
    e = 0
    else
    m = (m - 0.5) * 2^53
    e = e + 1022
    end

    local lo = m % 2^32
    m = (m - lo) / 2^32
    local hi = m + e * 2^20
    return lo, hi
end
```

#10-20

I need to take this week off to work on Compilers. I'm having an incredibly difficult time staying on top of everything.

#10-27

Got an email from Bolden, wasn't a reply.

Seem's like there's a wrokshop on how to build the Wiki page, so I guess I have to drop

some studying to attend.

Made a name for the Wiki: “Platform for XR Agriculture Education”

Sent out an email to Bolden for the rubber stamp on the name, because we apparently need it approved before we can make the Wiki. I wonder how long it’ll take before he replies? I’m not going to guess lol.

#10-29

No response for Bolden, so I’m going ahead and just making the Wiki. We can always delete it if he says no.

I asked Damon if he by chance sent multiple copies of the original Bolden email, and he actually has. These are the dates that he sent our email.

```
FWD: Tuesday, September 15, 2020 3:18:20 PM
FWD: Monday, September 21, 2020 5:39 PM
FWD: Tuesday, October 13, 2020 4:13 PM
FWD: Tuesday, October 27, 2020 4:25 PM
```

I can’t remember when the original email was sent, Damon only gave me the forwards.

They might only appear as forwards because he forwarded them to me, so September 15th may have been the first actually.

This was the email.

```
Dear Mr. Bolden,

I had a few questions about CS481 this semester. I did want to meet in person to discuss

    Is there a list of deliverables and/or scheduled snapshot days? You did mention snap
    How is our final grade calculated?
    Are there any deliverables you need to see right now?
    Is this course different from the traditional Spring-Fall sequence?

These are the questions that came to mind. My team and I are still working on the projec

Thanks,
Damon E Schafer
```

#11-8

- been working on the outline of the wiki and creating a list of things that need done. This is what I have so far

- Links to Logbooks
- Minutes
- Handoff materials
- Demo/vids
- Update Schedule

Which means I need to also flesh out my logbook, recompile it, scan in handwritten notes, etc etc. dang

I'm not sure what needs to be included in 'handoff materials' yet. I've just been perusing old resources that our team accidentally found and we've that this project is so much older than what we thought (by about a year, but still).

There's very, very little to show for all the combined effort of all of the history of this project. That being said, our team has really been struggling to work with the Farming Simulator API to get anything integrated, it's consumed probably 90% of our time.

#11-16

Working on the wiki, it's really frustrating to only now find other hints of the scope of what we've been trying to do. I filled out more about the background to the project, stuff about precision ag etc. The most frustrating aspect about all of this is how little anyone else seems to care about this project. Bolden STILL has not replied to our questions. I'm worried that we will be judged harshly because we didn't do our project "correctly".

This hasn't been the greatest insult to my time that the University has thrown at me though, Software Engineering and Algorithms are still the kings of worst "education" experiences I've ever had to endure, but this is pretty close up their.

At least with the other two classes, we actually received feedback.

#11-21

I've been focusing primarily on editing my logbook, working on grammar and spelling edits.

The only other thing I have planned is to do the same for the Wiki, Once I my logbook and my team's copies as well, I can link them on to the Wiki and get that wrapped up.

Re-reading has made me think I should cover a few more points.

Farming Simulator should be abandoned

Yea it's cool to have a full game ready to play VR in, _but you can't use Farming Simulator in VR unless you purchase both Farming Simulator, VorpX, and the gear.

We got f'd by assuming we needed to stick with Farming Simulator. I couldn't get the Lua 5.1 escape to work on x64 which meant implementing any sufficiently advanced modifications would be impossible - no callouts to connect state-of-the-art soil simulations, and also map manipulation is a big NO.

If any of the previous teams had tried to implement anything that we (I) had worked on, they would have realized this and informed the client. This alone has been a huge waste of time.

Sure, you can still write some mods for Farming Simulator that might be able to function for Dev's purposes, but only a few. Here are some features that while Dev never mentioned, I dreamed of when thinking of the future of this project.

- Precision Fertilizer
  - The actual goal of this project is to create simulations to train people on how to use new technologies for agriculture. As such, certain devices need to be implemented into the game because they're used extensively in this new field. iPad controlled drones with specialized cameras, GPS technology, and sensors would need to be added.
    * Implementing "GPS" into Farming Simulator has already proven to be a monumental task in terms of a semester's worth of work.
    * Drones *can* be implemented into Farming Simulator, but would need to be completely reworked (with a Lua Escape) in order to provide automated controls, and advanced camera feedback (IR at the very least would be incompatible) (Confer: https://www.youtube.com/watch?v=XVa7ewjSLsE)
    * Sensors would need to 'fake' any and all data about crops. This could be done, but it would tricky to make the data usable.
- Soil Erosion
  - The idea behind integrating some kind of soil erosion simulation is to try and understand how certain automated tractor paths may hurt the quality of a farm of long periods of time. As such, we would have liked to have an automated tractor path actual 'detent' a simulation field so that long term effects of this path could be visualized for students.
    * Ruts in the mud will hold water, and possibly create channels that displace the topsoil. Confer with my previous semester's worth of research for more information.