COVER SHEET FOR GRANT PROPOSALS
State Board of Education

SBOE PROPOSAL NUMBER: (to be assigned by SBOE)

AMOUNT REQUESTED: $74,700

TITLE OF PROPOSED PROJECT:
Darwin’s Demons Mobile: Expanding the Market for Evolutionary Procedural Content Generation

SPECIFIC PROJECT FOCUS:
The US video game market is expected to generate over 90 billion dollars per year by 2020. Barriers to entry into this market are very high because of the large and expensive teams required to produce increasingly complex and compelling game content. In a previous IGEM project, we developed and commercially released a tower defense game using evolutionary procedural content generation. This technique uses evolutionary models to evolve novel game content as the game progresses rather than relying on pre-programmed content. This approach was developed by Polymorphic Games, an interdisciplinary video game design studio at the University of Idaho. Evolutionary procedural content generation provides a unique competitive advantage to Polymorphic Games that positions us to produce compelling commercial games with significantly lower development costs. We have commercially released two games using this approach. Now, we seek $74,700 to develop Darwin’s Demons for mobile devices. The mobile game ecosystem is an important market for our game studio, representing a very large potential revenue source.

PROJECT START DATE: July 1, 2019
PROJECT END DATE: June 30, 2020

NAME OF INSTITUTION: University of Idaho
DEPARTMENT: Institute for Bioinformatics and Evolutionary Studies

ADDRESS: Office of Sponsored Programs, 875 Perimeter Drive, MS 3020, Moscow, ID 83844-3020

E-MAIL ADDRESS: esp@uidaho.edu
PHONE NUMBER: (208) 885-6651

SIGNATURE:

NAME: [Signature]

TITLE:

PROJECT DIRECTOR/PRINCIPAL INVESTIGATOR: Dr. Barrie D. Robison, Director, Institute for Bioinformatics and Evolutionary Studies

CO-PRINCIPAL INVESTIGATOR: Dr. Terrance Soule, Department Chair, Professor, Computer Science

NAME OF PARTNERING COMPANY: N/A
COMPANY REPRESENTATIVE NAME: N/A

Authorized Organizational Representative: Janet Nelson, Vice President for Research and Economic Development

SIGNATURE:
DARWIN'S DEMONS MOBILE: EXPANDING THE MARKET FOR EVOLUTIONARY PROCEDURAL CONTENT GENERATION.

1. INSTITUTION: University of Idaho

2. PROJECT DIRECTORS: Barrie D. Robison and Terence Soule


We commercially released "Project Hastur" on May 24th, 2019, which was funded by IGEM. Project Hastur is a 3D video game that fully implemented our technique for evolutionary procedural opponent generation. This project is different because we are taking University Intellectual Property from our first game (Darwin’s Demons) and developing a version for mobile devices.

4. EXECUTIVE SUMMARY: The US video game market is expected to generate over 90 billion dollars per year by 2020. Barriers to entry into this market are very high because of the large and expensive teams required to produce increasingly complex and compelling game content. In a previous IGEM project, we developed and commercially released a tower defense game using *evolutionary procedural content generation*. This technique uses evolutionary models to evolve novel game content as the game progresses rather than relying on pre-programmed content. This approach was developed by Polymorphic Games, an interdisciplinary video game design studio at the University of Idaho. Evolutionary procedural content generation provides a unique competitive advantage to Polymorphic Games that positions us to produce compelling commercial games with significantly lower development costs. We have commercially released two games using this approach. Now, we seek $74,700 to develop Darwin's
Demons for mobile devices. The mobile game ecosystem is an important market for our game studio, representing a very large potential revenue source.

5. PROJECT OBJECTIVE AND BUDGET REQUEST:

Our long-term goal is to "spin-out" Polymorphic Games into an independent, commercial game studio in Moscow, ID. The studio would provide jobs to Idaho students in a booming, high tech, multibillion-dollar industry. It would publish its own games, serve as a publishing vehicle for independent student games, and develop "asset packages" to license to game companies seeking to use evolutionary procedural content generation.

*Our objective is to bring a mobile game to market that uses evolutionary opponent generation.* Achieving this objective would: 1) Increase the market reach of our game studio, 2) Provide a concrete example of success in the mobile market to help attract investment capital, and 3) Move us toward establishing an independent company with close ties to Idaho’s Universities. To achieve this objective, we request $74,700.

*Evidence of Prior Success:* Polymorphic Games has developed two commercial games that use evolutionary procedural generation of enemies. For each game, we have shown empirically that the evolutionary component meets its intended objectives: the game gets more difficult over time and the opponents’ appearance, behavior, and traits adapt to the choices and strategy of the player.

Our first game, Darwin’s Demons ([https://store.steampowered.com/app/572020/Darwins_Demons/](https://store.steampowered.com/app/572020/Darwins_Demons/)) was designed as a critical test of our development strategy and was released commercially on the Steam platform February 13th, 2017 (the day after Darwin Day). We then used previous IGEM funding to incorporate evolutionary opponent generation into a tower defense game in
which the player builds defensive emplacements to defend against waves of opponents. Normally the opponents in a tower defense game become increasingly difficult following a fixed, programmed schedule. This limits player interest and replayability. Our evolutionary procedural generation produced a uniquely compelling and highly replayable game experience even over multiple replays. Project Hastur (https://store.steampowered.com/app/800700/Project_Hastur/) was released into early access on Darwin day of 2018, and into full release in may 2019.

6. THE MARKET OPPORTUNITY:
Ultimately, commercially successful games provide two components to their customers: Complex and compelling content, particularly in the appearance and behavior of the opponents, and replayability - which contributes to the perceived value to the player. Developing these components is expensive, usually requiring a large development team to create content and to program many alternative paths for game play. An alternative, and equally expensive approach, is to develop online games that allow humans to compete against each other. This approach particularly appeals to hardcore gamers who want the challenge of adaptable opponents rather than opponents that follow a pre-programmed script.

Our Value Proposition: Unlike any other commercial studio, Polymorphic Games uses evolution to inexpensively create complex, compelling, and replayable content. The opponents in our games evolve in response to the player’s choice; the most successful opponents have the most opportunities to “reproduce,” populating later stages of the game. Thus, as the game proceeds the player encounters increasingly complex and challenging opponents. When a player chooses to replay
the game using a different strategy the opponents will adapt to that strategy, creating an entirely different and uniquely challenging game play experience.

**Applications, Markets, and Demand**

**Market Segment 1: “Gamers”** Almost 200 million people play video games in North America alone and the rate of engagement in this form of entertainment is increasing rapidly. The US video game market is expected to generate over 90 billion dollars in 2020. Our technique can be applied to almost any game genre, providing a large potential user base.

**Market Segment 2: “Educators and Parents”** Our games are built upon accurate models of biological evolution. Thus, our games have significant potential for teaching concepts in biology, evolution, and genetics. We can market our games to middle school and high school teachers (and college professors), and to parents desiring games with educational value.

**Our Competition and our Competitive Advantage:** We obviously do not seek to compete (yet) with AAA game studios with billion dollar budgets. Our competition is other “indie” game design companies, ranging in size from 1 to 10 employees. Polymorphic Games has three main competitive advantages over other indie studios: 1) Access to non-dilutive capital in the form of grants, 2) Access to highly talented student developers from a wide range of disciplines, and 3) Low overhead costs while the startup company is incubated.

**Barriers to Entry:** The barriers to market entry for our next game include development through the beta stage, extensive testing and refinement, and support during the first few months of commercial release. These barriers would be overcome with the proposed incubation funding.
7. TECHNOLOGY AND THE PATH TO COMMERCIALIZATION:

Our Technology: Evolutionary procedural content generation uses evolutionary algorithms to evolve game content as the game is being played. The opponents in our games are modeled as biological populations and feature a digital genome that controls their appearance and behavior. The opponents that perform the best, survive the longest, do the most damage to the player, etc. pass those genes to their offspring in the next level/wave of the game.

Market Need and Intellectual Property Status: Evolution based procedural content generation creates game content that is much more compelling than randomly generated content at a much lower cost than scripted content generated by a large development team. This approach provides a significant competitive advantage to Polymorphic Games. UI owns the Intellectual Property associated with Darwin’s Demons. The technology was developed at UI by Drs Robison and Soule with funding from NSF through the BEACON Science and Technology Center (of which UI is a partner) and the Vandal Ideas Project.

8. INSTITUTIONAL SUPPORT:

UI has been extremely supportive of this project. We have space in the new Integrated Research and Innovation Center (IRIC). Our location is ideal for Polymorphic Games because it supports the interdisciplinary nature of the studio. Our project aligns with several aims of the UI Strategic Plan.

Aim 1: Scholarly and creative productivity at the highest level, resulting in designation as a Carnegie Highest Research Activity (R1) Institution.
Developing methods for procedural content generation in video games is a new and very active research area. However, our approach of using evolution to procedurally generate opponents is unique. Darwin’s Demons and Project Hastur are the only commercial game on the market using this approach, creating many research opportunities.

**Aim 2: Suggest and influence change that impacts societal needs, global issues, economic development and advancement of culture.**

We seek to develop a third commercial product and, more importantly, a sustainable game design company that will continue to produce new products (games and licensed software). Ideally, our project will provide positive evidence that successful video games can be developed in Idaho, rather than requiring relocation to a current hub of the video game industry.

**Aim 3: Advance our educational impact.**

This project will develop significant human capital in Idaho. The studio experience teaches students how to work in broadly interdisciplinary and collaborative teams – a key skill in industry. The game studio will also help attract and retain Idaho students in higher education. Our studio has interacted with thousands of students, ranging from 3rd grade to incoming freshman. The response to the studio has been uniformly positive with many students expressing an increased interest in attending college and in attending the UI rather than going out of state. UI’s media center has spearheaded a number of media events leading to articles in local, state, and national news outlets. The Office of Technology Transfer has worked closely with us to develop the necessary legal and royalty agreements.
**Unique Infrastructure:** The broad range of technical expertise available at UI is a unique strength of Polymorphic Games. We have access to all of the expertise necessary to create successful video games (programming, design, music, business, etc.), plus access to the experts in evolutionary biology necessary for successful evolutionary content generation. This access to experts in evolutionary biology is one of the studio’s key competitive advantages over other game studios.

**9. COMMERCIALIZATION PARTNERS:** Currently Polymorphic Games is entirely on-campus, UI based game studio and UI is the only commercialization partner.

**10. SPECIFIC PROJECT PLAN:**

Our purpose with this request is to *bring a mobile version of Darwin’s Demons to commercial release*. Below, we describe the milestones in our development process.

**Development Milestones and the Path to Commercialization**

1. Initial game design and rough mock-ups. Complete.
2. Initial game prototype. Complete
4. **Acquire iOS and Android SDKs.** Summer 2019.
9. **Advertising** - targeted, online advertising based on keywords in Google search, Facebook, and similar platforms. Winter - Summer 2019.


**Development Team**: Landon Wright is the project lead for the game studio. He is an accomplished artist and has been with the studio since its inception. He will responsible for supervising the student developers and for artistic vision of the project. We will also hire a programmer and an additional artist to assist with creating project assets. The overall project will be overseen by Drs Robison and Soule.

11. **Criteria for measuring success:**

Our success criteria are related to recruitment, development, and distribution. We will **recruit the team** (artist and programmer) by August 2019. Development metrics include the production of a **playable beta** (Feb 2020), a **prerelease build** (April 2020), collection of **testing data** (May 2020), and **full release** (June 2020). Distribution metrics include **sales on iOS and Android** (July 2020 and beyond).
### SUMMARY PROPOSAL BUDGET

**Name of Institution:** University of Idaho  
**Name of Project Director:** Barrie D Robison

#### A. PERSONNEL COST (Faculty, Staff, Visiting Professors, Post-Doctoral Associates, Graduate/Undergraduate Students, Other)

<table>
<thead>
<tr>
<th>Name/ Title</th>
<th>Salary/Rate of Pay</th>
<th>Fringe</th>
<th>Dollar Amount Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landon Wright, Lead Designer</td>
<td>$37939</td>
<td>$15985</td>
<td>$53304</td>
</tr>
</tbody>
</table>

- **Programmer (To be recruited)**: $8000  
- **Artist: (To be recruited)**: $8000

**% OF TOTAL BUDGET:** 94.7%  
**SUBTOTAL:** $70,700

#### B. EQUIPMENT: (List each item with a cost in excess of $1000.00.)

<table>
<thead>
<tr>
<th>Item/Description</th>
<th>Dollar Amount Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUBTOTAL:** $0

#### C. TRAVEL:

<table>
<thead>
<tr>
<th>Dates of Travel</th>
<th>No. of Persons</th>
<th>Total Days</th>
<th>Transportation</th>
<th>Lodging</th>
<th>Per Diem</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUBTOTAL:** $0

#### D. Participant Support Costs:

<table>
<thead>
<tr>
<th>Dollar Amount Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**SUBTOTAL:** $0
### E. Other Direct Costs:
**Dollar Amount Requested**

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Materials and Supplies</td>
<td></td>
</tr>
<tr>
<td>2. Publication Costs/Page Charges</td>
<td></td>
</tr>
<tr>
<td>3. Consultant Services (Include Travel Expenses)</td>
<td></td>
</tr>
<tr>
<td>4. Computer Services</td>
<td></td>
</tr>
<tr>
<td>5. Subcontracts</td>
<td></td>
</tr>
<tr>
<td>6. Other (specify nature &amp; breakdown if over $1000)</td>
<td></td>
</tr>
<tr>
<td><strong>Software</strong>: Software licenses for Unity, our game development engine ($1,500), and Adobe Creative Cloud, our art and media software ($480). <strong>Advertising</strong>: We request $2,000 to support the marketing and advertising of our game (including ads on google adswords, Facebook, and other social media outlets)</td>
<td>$1980</td>
</tr>
<tr>
<td><strong>SUBTOTAL:</strong></td>
<td><strong>$4000</strong></td>
</tr>
<tr>
<td>F. Total Costs: (Add subtotals, sections A through E)</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>$74,700</strong></td>
</tr>
<tr>
<td>G. Amount Requested</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>$74,700</strong></td>
</tr>
</tbody>
</table>

**Project Director’s Signature:** [Signature]

**Date:** 6/21/2019

### INSTITUTIONAL AND OTHER SECTOR SUPPORT
(add additional pages as necessary)

<table>
<thead>
<tr>
<th>A. INSTITUTIONAL / OTHER SECTOR DOLLARS</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source / Description</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. FACULTY / STAFF POSITIONS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. CAPITAL EQUIPMENT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D. FACILITIES &amp; INSTRUMENTATION (Description)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
APPENDICES
Appendix 1: Facilities and Equipment.

1. Polymorphic Games: Our game studio is housed in the Integrated Research and Innovation Center, a brand new building in which interdisciplinary research projects that transcend colleges are cultivated. The studio features 3 powerful workstations and 3 laptop computers for software development, and the necessary software for game development (Unity, Adobe Creative Cloud, Zbrush, etc). The studio also has two HTC Vive units and several tablets and mobile devices.

2. Institute for Bioinformatics and Evolutionary Studies (IBEST): IBEST is a Tier III Institute at the University of Idaho, and houses the administrative and technical staff to support the proposed project. This includes budget management and project oversight, as well as high performance computing and data science infrastructure. The project PI (Robison) is the Director of IBEST.
BIOGRAPHICAL SKETCH for Barrie D. Robison
Professor, Biological Sciences

875 Perimeter Dr MS 3051
Dept of Biological Sciences
University of Idaho
Moscow, ID 83844-3051
brobison@uidaho.edu

A. Professional Preparation

<table>
<thead>
<tr>
<th>Institution</th>
<th>Major or Area</th>
<th>Degree &amp; Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. Victoria</td>
<td>Biology</td>
<td>B.S., 1993</td>
</tr>
<tr>
<td>Univ. Idaho</td>
<td>Fisheries</td>
<td>M.S. 1995</td>
</tr>
<tr>
<td>Washington State Univ.</td>
<td>Zoology</td>
<td>PhD. 2000</td>
</tr>
<tr>
<td>University of Oregon</td>
<td>Evolutionary genetics</td>
<td>Postdoctoral work; 2000-2001</td>
</tr>
<tr>
<td>Indiana University</td>
<td>Evolutionary genetics</td>
<td>Postdoctoral work; 2001-2003</td>
</tr>
</tbody>
</table>

B. Appointments

2018 – current    Director, Institute for Bioinformatics and Evolutionary Studies
2016 – current    Professor, Department of Biological Sciences, University of Idaho.
2014 – 2018       Associate Director, Institute for Bioinformatics and Evolutionary Studies
2009 – 2016       Associate Professor, Dept of Biological Sciences, University of Idaho.
2003 - 2009       Assistant Professor, Dept of Biological Sciences, University of Idaho.

C. Products

(i) Five Most Relevant Products (* indicates corresponding author)


Nicholas Wood, Terence Soule, Barrie D. Robison*, Samantha Heck, and Landon Wright. 2016. Darwin’s Demons [computer software]. Published by the University of Idaho and Valve Corporation (Steam).

http://store.steampowered.com/app/572020/Darwins_Demons/


(ii) Five Other Significant Publications (* indicates corresponding author)


D. Synergistic Activities

i. Member, Society for the Study of Evolution Education Committee
ii. Co-organizer, 2009 Conference of the Society for the Study of Evolution (Moscow, ID)
iii. Member, Higher Education Video Games Alliance
iv. Consultant, "Math Fire" – a game designed to teach young children number sense and mathematics.

Current and Pending Support: [Barrie Robison, University of Idaho]

Support: Current

None

Support: Pending

Project/Proposal Title: Darwin's Demons Mobile: Expanding the Market for Evolutionary Procedural Content Generation [this proposal]
Source of Support: Idaho State Board of Education
Total Award Amount: $74,700
Total Award Period Covered (start date to end date): July, 2019 – June, 2020
Location of Project: Moscow, Idaho
Person-Months per Year Committed to the Project: Cal: 0

Project/Proposal Title: Harnessing the Date Revolution to Enhance Economic Growth in Idaho
Source of Support: National Science Foundation
Total Award Amount: $1,954,025
Total Award Period Covered (start date to end date): July 1, 2019 – June 31, 2022
Location of Project: Moscow, Idaho
Person Months per Year Committed to the Project: Cal: 1

Project/Proposal Title: THE EVOLUTIONARY ARCADE: A game based context for informal learning of evolutionary biology [This proposal]
Source of Support: National Science Foundation
Total Award Amount: $2,400,094
Total Award Period Covered (start date to end date): August 1, 2019 – August 1, 2024
Location of Project: Moscow, Idaho
Person-Months per Year Committed to the Project: Cal: 1

2
Terence Soule  
Professor of Computer Science  
University of Idaho, JEB 229, Moscow, ID, 83844  
(208)-885-7789; tsoule@cs.uidaho.edu  

Professional Preparation  
Reed College  
Washington State University  
University of Idaho  

Physics  
Physics  
Computer Science  
B.A., 1991  
M.S., 1994  
Ph.D., 1998  

Appointments  
Chair, Computer Science, University of Idaho 2018 - present  
Professor, Computer Science, University of Idaho 2013 – present  
Director, Neuroscience Program, University of Idaho, 2009 - 2012  
Associate Professor, Computer Science, University of Idaho, 2006 – 2013  
Assistant Professor, Computer Science, University of Idaho, 2000 - 2006  
Assistant Professor, Computer Science, St. Cloud State University, 1998 – 2000  

Products  
Five Products Related to this Proposal  

Synergistic Activities  
1. Chair of the Computer Science Department, 2018 – present.  
2. Member of the IBEST Steering Committee  
3. Taught multiple programming camps for middle and high school students as part of the Dig’n IT program (http://www.uidaho.edu/cda/extension-outreach/dignit), 2013-present
4. Taught multiple high school teacher training workshops to prepare teachers to offer dual credit computer science
5. Member of the Education and Human Resource Development steering committee and Education and Human Resource Development lead for the University of Idaho for the BEACON NSF Science and Technology Center for the study of Evolution in Action.
6. Member, SIGEVO Executive Board (ACM Special Interest Group for Genetic and Evolutionary Computation), 2013 to present

Current and Pending Support: [Terence Soule, University of Idaho]
Support: Current

1. Project/Proposal Title: Configurable AUV Electric and Magnetic Field Sensor Network
   Source of Support: Office of Naval Research
   Total Award Amount: $1,838,547
   Total Award Period Covered: 01/01/2017-12/31/2019
   Location of Project: University of Idaho
   Role in Project: Co-PI
   Person-Months per Year Committed to the Project: 0.5 of a month, summer

2. Project/Proposal Title: Computer Science Dual Credit Expansion
   Source of Support: Idaho STEM Action Center
   Total Award Amount: $25,046
   Total Award Period Covered: 05/15/2019-08/30/2019
   Location of Project: University of Idaho
   Role in Project: Co-PI
   Person-Months per Year Committed to the Project: 0.25 of a month, summer
   Support: Pending

3. Project/Proposal Title: Darwin’s Demons Mobile: Expanding the Market for Evolutionary Procedural Content Generation [this proposal]
   Source of Support: Idaho State Board of Education
   Total Award Amount: $74,700
   Total Award Period Covered (start date to end date): July, 2019 – June, 2020
   Location of Project: Moscow, Idaho
   Person-Months per Year Committed to the Project: Cal: 0

4. Project/Proposal Title: THE EVOLUTIONARY ARCADE: A game based context for informal learning of evolutionary biology
   Source of Support: National Science Foundation
   Total Award Amount: $2,400,094
   Total Award Period Covered (start date to end date): August 1, 2019 – August 1, 2024
   Location of Project: University of Idaho
   Person-Months per Year Committed to the Project: 1

5. Project/Proposal Title: A Transformative Online Learning Approach to Enhance GenZ Learning in Engineering Courses
   Source of Support: University of Idaho
   Total Award Amount: $50,000
   Total Award Period Covered (start date to end date):
   Location of Project: University of Idaho
   Person-Months per Year Committed to the project: 1.5