Woolf
The First Blockchain University

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Dr Joshua David Broggi (Oxford), Mr Martin Albert Gallagher (Oxford), Mr Johann Lilly, Dr Jonathan Duquette (Oxford), Dr Courtney Nimura, Dr Miles Pattenden (Oxford), Dr Felix Richter (Giessen), Dr Lola San Martín Arbide (Oxford), Dr Shahar Avin (Cambridge), Dr Kate Kelley (Oxford), Dr Maria Lidova (Oxford), Dr Diana Rodríguez-Pérez (Oxford), Dr Andreas Winkler (Oxford)

Synopsis

Woolf will be the first blockchain-powered university with its own native token. The design has been developed by an independent group of academics (mostly from the University of Oxford), and experienced academics will form the first college in the collegiate university.

Woolf will be a borderless, digital educational society which reimagines how teachers and students connect. It will rely on blockchains and smart contracts to guarantee relationships between students and educators. For students, it will be the Uber of degree courses; for teachers, it will be the Airbnb of course hosting, but for both parties the use of blockchain technology will provide the contractual stability needed to complete a full course of study.

It is our view that the model set out in this white paper will disrupt the economics of higher education and provide new opportunities for both students and academics. Blockchains with smart contracts can automate administrative processes and reduce overhead costs. Students can study with lower tuition and academics can be paid higher salaries.

It is our ambition that Woolf be a revolution without precedent in the history of the university. But at its core, Woolf makes possible the oldest and most venerable form of human education: direct personal, individual apprenticeships in thinking. And Woolf brings that transformative experience to the world. We believe such a personal education will be increasingly valuable as artificial intelligence and robotics gain an ever-greater share of the current jobs.

Woolf is geographically agnostic. The platform will be digital in its organisation, and it will facilitate personal teaching through channels like Skype, but it will equally support traditional, face-to-face teaching. Students may elect to study in-person with local

teachers, but they are more likely to find the best quality course, matching their interests, if they look beyond their local horizons. Woolf is not like other digital universities. Woolf will simply use digital technologies to reimagine how traditional forms of education can be sustained in a geographically agnostic manner.

Unlike all existing digital universities, and unlike almost every physical university, the Woolf education will mostly consist of one-to-one personal tutorials. The smart contracts on the Woolf blockchain will dramatically reduce the need for a traditional university's administrative staff. Indeed, we hope many traditional universities will adopt Woolf and increasingly phase out their administrative staff.

The Woolf platform is designed to reduce bureaucracy, lower tuition costs, secure teaching salaries, and increase the time that students interact with their professors. The result will be simple and powerful: students and teachers are brought together, no matter where they are in the world.

Woolf offers new employment practices. Colleges of experts can form without regard to borders. Professional academics can form new colleges on the platform provided that they meet the minimum criteria. Like adding properties on Airbnb, new colleges can be added at any time by the academic community. The platform will aim to provide a turnkey experience for academic professionals forming new colleges and offering courses.

The first colleges of Woolf University will seek accreditation for their degrees through traditional legal pathways. This will improve relations with governments and attract further benefits, like student financial aid. However, Woolf will seek to formulate the global standard in degree credentials on the basis of the largest democratic exercise ever conducted among academics; such degrees would be automatically and irrevocably accorded to those satisfying specific blockchain conditions.

Statements in this white paper reflect our hopes for the Woolf network and not its current abilities. We prize democratic values and feedback on our design. After launching and developing the network, its governance will be passed over to the academic members and the non-profit Woolf Trust. Given the decentralised character of the network, our statements cannot be read as promises within our managerial control to fulfil. We aim to launch the Woolf network with: (1) a basic version of the check-in procedure (4.4 'Check-In'), (2) the potential for further development because democratic mechanisms allocate the native token to projects, and (3) world-class academics registered as members. Of course, our ambitions are greater.

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1. Overview

Higher education today faces two great problems: student debt and adjunct teaching. We are creating a novel solution.

Students face mounting costs that prevent many bright students from getting the best education. Academics face increasingly insecure employment, preventing many from leading a fulfilling career. Woolf is designed to reconnect students and teachers.

Underemployment among academics, and poor coordination with students, is the intellectual equivalent of allowing the most expensive real estate in London or New York to sit empty. In the same way that we saw Airbnb allow for a better allocation of real estate resources, we believe that Woolf can make better use of our academic resources.

Woolf will be a borderless university in a global world. It will provide students with clear opportunities to receive affordable and personal teaching. Blockchains and smart contracts will relieve educators of administrative tasks, lower costs, and allow the core educational experience to prevail, namely one-to-one teaching between academics and their students.

The smart contracts hosted on the blockchain network will liberate teachers to do what no bureaucratic process can accomplish: understand students and teach them how to think. We believe this is the sort of education that will be most needed in the coming century, an education that is not replaceable by machines.

Woolf will use a decentralised blockchain network to support a democratic federation of teaching institutions on the collegiate model of self-organisation. Other collegiate

universities with a federal system include the Universities of Oxford, Cambridge, London, Delhi, Sydney, and California. Although colleges may elect to govern their internal affairs with great diversity, the network-level rules of Woolf, including the common framework for colleges, can only be changed through democratic consensus (7. University Processes).

As simply as hailing a cab with Uber, or booking a room on Airbnb, students can find personal instruction from an expert, or apply to study for a full degree. Woolf will provide professors with transparent employment opportunities in contractually secure work of their choosing. As simply as organising an academic conference, or hosting property on Airbnb, a group of professors can start a new college and obtain gainful employment doing what they do best.

The essential administrative tasks of Woolf will be handled by smart contracts. Smart contracts execute under specific conditions – for example, if the student and teacher both accept that a tutorial has begun, the course credit will be accorded to the student's blockchain record and the payment will be accorded to the teacher's account. The smart contracts are hosted on the network, which uses its own native token, WOOLF. Exchanges transacted through the network's utility token will eventually allow the student and teacher to use their own currency of choice. The bulk of administrative tasks will be automated by smart contracts linked to the token.

Such a procedure of agreeing to a tutorial can be quickly performed on a Woolf University app, whether the tutorial is conducted in-person or over Skype (4.4 'Check-In'). At first, it may seem strange for two people to select a button on their phones before starting a lesson, but doing so removes the need for a host of administrators and protects both parties within the contractual agreement. In the future, we believe that such a 'check-in' procedure will be as normal as taking notes in a meeting. In addition to hosting new colleges started by academics, Woolf plans to help existing colleges and educational institutions adapt to these changes and join the Woolf network.

The terms of a smart contract cannot be circumvented because they are coded into the blockchain. This protects both parties. The terms of a smart contract are adjustable and can contain multiple parameters, which colleges can seek to revise through a democratic process. A smart contract can stipulate that a student who fails to 'check-in' to a tutorial, within a given window of time, would still pay the teacher but receive no credit on their record. A smart contract could also stipulate that a delinquent teacher provides the student a refund and pays a fine to the University. The terms of a smart contract are open to democratic debate and determined by consensus; once set, they no longer require management to run.

This allows teachers to concentrate on what they do best; it enables students to receive personal attention; and it ensures that each party is protected by the terms of the contract. Eventually, those administrative tasks which cannot be automated will be incentivised with the native token, or where appropriate, put out to bid to anyone who is willing to act as administrator regardless of their institutional or geographical location (7.5.2 The Administrative Bidding Pool).

The aim of Woolf is a reorganisation of the way human knowledge circulates around the globe. Consider Airbnb. With 3,000 employees they host 4 million property listings and oversee 2 million rentals per day, involving more than 200 million unique users over the last decade.[1] In principle, we believe that a blockchain makes it possible for these ratios between administrators and users to be matched and surpassed – in a non-profit, decentralised educational society where students can afford to study in small tutorials with the world's experts.

The first college in the federal system, Ambrose, will be composed of a group of experienced educators, mostly with a background of training from the University of Oxford, and we will invite colleagues from Cambridge to form the second college. As with Oxford and Cambridge, the core teaching of Ambrose will consist of personal tutorials. Tutorials for a class (or 'paper') consist of 8 meetings on a single topic over an 8-week term. Once a week, one or two students will meet with a tutor for one hour to discuss an essay they have written on the basis of assigned readings and podcasts. A full course load for a student consists of 2 classes, which is 2 tutorials per week. The academic year consists of 3 terms of 8 weeks. As with a typical undergraduate degree at a place like Oxford, a degree at Ambrose on the Woolf platform will consist of 144 tutorial meetings over 3 years. Tutors can always provide an extra meeting to help students with their studies. Offering such an education through Woolf University could result in dramatically lower student fees and substantially higher faculty pay (8. Revenue).

New colleges on the Woolf network will have their own arrangements and present their own smart contracts, but these cannot violate the rules of the common framework for colleges without a network-level consensus. The collegiate system is essential to Woolf because the terms of any course of study are determined at the level of the college and encoded into the smart contracts that bind students and teachers in the college. Democratic consensus down at the college level can change collegiate contracts, whereas only consensus up at the network level can change the framework that relates all colleges in the federal university, including the common framework dictating internal college affairs. The collegiate system makes it possible for colleges to distinguish themselves in numerous ways, without demanding consent across a subject area or across the whole network; colleges may differ in language, price, quality, geographical preference, and in the degrees offered – provided that they meet the terms of Woolf University and the common framework for colleges.

As Woolf grows, and the network becomes saturated, more teachers and more students would give all participants greater choice. Geographic saturation will make it

[1] https://press.atairbnb.com/app/uploads/2017/08/4-Million-Listings-Announcement-1.pdf

possible to run more courses in-person, and not merely over the internet. When desirable, on-site instruction will allow students of history to study Caesar in Rome or Chinese Emperors in Beijing; art students might meet with their professor in a museum. This will allow students to use local resources and primary evidence as they develop the skills of fundamental research. In each case the smart contract governs the relationship and stipulates the conditions.

The core transaction in the Woolf system is the tutorial agreement. When both parties agree that the tutorial has begun, the blockchain automatically transfers funds to the academic and course credit to the student. Smart contracts will delineate whether further terms are involved. The tutorial agreement may have a specified window of time, a specific platform like Skype, a geographical location, or the precondition that students submit a tutorial essay in advance by a specific deadline. Smart contracts can further delineate whether a student or professor is economically penalised for failing to check into the tutorial, thereby giving both parties security and assurance.

Woolf is positioned to disrupt higher education by offering students a personal education at a remarkable cost. The existing model, in which hundreds of students sit in a classroom, is no longer competitive: these same courses, and often better ones, are available online for no cost. The existing model, in which students memorise information, is no longer competitive: computers are simply better at information storage, and students need the tools of judgment to navigate large volumes of information. The existing model, in which students have limited access to their professors, is no longer competitive: Woolf aims to provide all students with a personal education.

Woolf University offers a novel solution to a widespread problem, and it is positioned to disrupt a major industry by changing the core employment practices for academics. We have a clearly delineated addressable market. Today, most academics must *ask for permission* to practise their profession, regularly applying to their universities to keep their jobs. Our analysis indicates that, in the current system of academic employment, the majority of academics, who compose the majority of university faculties, and who conduct proportionally more of the university's business, face an employment crisis that threatens to uproot their families and overturn their financial planning (2. The Problem). Most academics work on short-term contracts that expire every few years. Such a system benefits incumbent stakeholders by using the threat of unemployment to guarantee high productivity with lower salaries. We do not believe that this benefits students or academics. These academics and their students compose our first addressable market.

At Woolf University, qualified academics can simply start their own colleges without asking for permission. That is our goal. Every certified academic who seeks a job can make one and keep it by starting or joining a college. As the University grows, neither visa provision, nor government travel constraints will determine the success of qualified academics and their students. That is transformative. By relying on novel technological solutions like smart contracts hosted on a blockchain, Woolf University is relieved of the incentive to exploit its members. That is elegant.

2. The Problem

Most academics under 45 years old in western countries cannot obtain fulltime, long-term employment in their profession; they spend much of their time searching for work. Most students cannot study directly with a professor, or they must accept a high debt burden if they do. Here we present a market analysis, to be read as our best efforts.

2.1 Diagnosing the Problem

The incentive problem. The current university system consists of badly aligned incentives with damaging outcomes for all stakeholders. University administrations are incentivised to increase numerically measurable activities as an assurance of quality; this produces higher tuition fees, growing administrative staffs, unnecessary building projects, and lower pay for most academics. University students are incentivised to adopt ever-larger debts, to cheat or produce formulaic and safe answers, even while gaining diminishing access to their professors. Professors are incentivised to reduce direct contact with students, increase the number of their measurable outputs at the expense of quality, and increase their unpaid hours of work.

We believe that Woolf University will realign the incentives of all stakeholders. It will reverse the vicious circle of perverse incentives and make a virtuous circle of beneficial incentives. Administrations will support teachers who support students.

The opaque barrier problem. In the current university system, both students and professors are made to trust in opaque processes of decision-making with high-stakes for their own well-being and future careers. These processes may depend upon unstated criteria, which risk disadvantaging some participants, creating ill will, and failing to incentivise appropriate improvement. Professors and students often lack powerful democratic mechanisms by which they can improve outcomes for their own advancement in the university system.

We believe that Woolf University, as the first blockchain university, will allow decision-making processes to be more transparent, accountable, and trustworthy. Students and academics will have more stability in their agreements, more democratic power, and more options overall. This will give both students and academics greater control over their success.

The 'market-maker' problem. In the current university system, universities are like trading exchanges in which administrations benefit from 'market-maker pricing', with large bid-offer spreads between student tuition and teacher pay. As a consequence, students (or tax payers) shoulder heavy costs and academics receive low compensation.

We believe that Woolf University, as the first blockchain university, will increase the efficiency of student-teacher coordination by removing intermediaries, thereby narrowing spreads between hourly tuition costs and academic wages, thus distributing money more transparently, democratically, and justly.

The market liquidity problem. Traditional universities typically fail to coordinate students with teachers when these are not already in the same location and sharing in the same local network of information. Asymmetries often develop that leave buyers without sellers (students without teachers for their desired class) or sellers without buyers (teachers without sufficient student enrolment).

We believe Woolf can solve the liquidity problem by putting more players in the same network. Woolf supports a liquid market (1) by allowing any potential student to join the university platform, (2) by allowing any qualified professor to teach on the platform, and (3) by removing geographical barriers to the coordination of teachers and students. Although colleges will always have the obligation to teach their own students, they cannot silo their own students from the wider market; if a college fails to offer a promised course, the student will have many qualified alternatives in the network, and all colleges must recognise qualified courses for credit. Although colleges will always have the right to refuse a professor entrance to the college, the college cannot silo its teachers from teaching other students in the wider network market. All parties can maintain their affiliations while connecting in a tuition bidding pool (7.5.1 The Tuition Bidding Pool). Call this asymmetrical college porosity.

2.2 The Consequences of the Problem

2.2.1 Consequences for Academics

The majority of academics in the United States,[2] the United Kingdom,[3] and Germany[4] work on insecure, fixed-term employment contracts or part-time contracts or 'adjunct' contracts. The problem of temporary employment is widespread across the academic employment sector. It is especially acute at some of the best universities. The University of Oxford is representative of the Russell Group, which is slightly above the British average. At Oxford, 63.7% of its faculty members are on temporary contracts, and over 80% of its research is conducted on temporary contracts.[5]

Insecure contracts are characterised by full-time employment with a fixed date of employment termination. In practice, these positions offer a fraction of the pay compared to the same work conducted on a secure contract. Academics on insecure

[2] Trends in The Academic Labor Force, 1975-2015' in The American Association of University Professors March 2017. Available online: https://www.aaup.org/issues/contingent-faculty-positions/resources-contingent-appointments.
[3] Jack Grove, 'Fixed-term now the norm for early career academics, says UCU' in The Times Higher Education 14 April 2016. Available online: https://www.timeshighereducation.com/news/fixed-term-now-the-norm-for-early-career-academics-says-university-and-college-union-ucu.
[4] 'Key points for an initiative on behalf of early career researchers in higher education' in HRK: Hochschulrektorenkonferenz. Die Stimme der Hochschulen 11 November 2015. Available online: https://www.hrk.de/press/press-releases/press-release/meldung/key-points-for-an-initiative-on-behalf-of-early-career-researchers-in-higher-education-3875/
[5] Adity Chakrabortty and Sally Weale, 'Universities accused of "importing Sports Direct model" for lecturers' pay' in The Guardian 16 November 2016. Available online: https://www.theguardian.com/uk-news/2016/nov/16/universities-accused-of-importing-sports-direct-model-for-lecturers-pay. Louis Richardson, Vice Chancellor of the University of Oxford, stated in public forum for the members of Congregation that 84% of Oxford research was conducted on temporary contracts, 'Vice-Chancellor's Question Time: Monday 21 November 2016'.

contracts are vulnerable to exploitation, and they often compete for further insecure contracts by working unofficial and unpaid hours.

Unlike lawyers or doctors, qualified academics constantly ask for permission to practise their profession – they do not set up their own chambers or open their own medical practices. Academics with fixed-term contracts must spend a significant portion of their time searching for another fixed-term contract; this adversely affects both their core duties and their contributions to society. In between fixed-term contracts, academics often face lean years in which they have no income and must exhaust their savings or rely on state-aid, while waiting for the next cycle of applications. It is our view that the material and psychological costs of this pattern are damaging to society.

The smart contracts on the Woolf blockchain will keep a secure and predictable level of income in an academic's workflow. The high liquidity of the Woolf marketplace will indicate the success conditions to better pay – an optional class in Estonian Basket Weaving may not attract many students compared to the elective on Soviet Rule in Estonia, but at the same time, fewer academics will possess this specialised expertise (7.5.1 The Tuition Bidding Pool). Moreover, the market will provide stable teaching opportunities for academics, without requiring a fundamental change in their geography or pattern of life. Academics can always band together to form a college and later purchase property.

The rate of insecure employment across academia is significantly higher among younger academics than among older academics. The situation is often worse than the statistics depict because they average the age groups. Under current conditions, the newest generation of academics will not progress into secure employment like the previous generation. Temporary contracts have become the rule for a new generation of academics. This has disrupted their quality of life, their family planning, and their financial planning. Although some academics voluntarily choose insecure contracts for personal reasons, most of those who seek secure employment cannot gain it. Their reports of dissatisfaction with their employment situation are well-documented.[6] *Yet these same academics fill classrooms with students who could pay their salary many times over and keep them comfortably employed.*

2.2.2 Consequences for Students

Students in many countries face increasing debt burdens, which adversely affect their mental health.[7] Debts may increase pressure on students and incentivise cheating on examinations, plagiarism in essays, and the reliance on safe or formulaic answers. Despite increasing costs, personal access to expert professors is often minimal. Professors often rehearse the same material every year, even though students could watch it on YouTube or, indeed, see it done better on YouTube.

[6] https://www.chronicle.com/blogs/ticker/adjuncts-blame-workplace-disrespect-for-job-dissatisfaction/98369 , https://www.chronicle.com/article/Why-Are-Associate-Professors/132071

[7] Cooke, Richard and Barkham, Michael and Audin, Kerry and Bradley, Margaret and Davy, John, 'Student Debt and Its Relation to Student Mental Health' in Journal of Further and Higher Education 28 (2004): 53-66. The mental health charity Mind regularly reports on the problem: Mind.org.uk

We do not feel that students are best served by professors who lack stability of employment and reliable employment conditions. We do not feel that students are best prepared for the future by learning formulaic answers en masse. We worry that administratively fixed courses, designed to be repeated every year by various adjunct lecturers, will fail to keep track of developments in research, and will disadvantage the economically poorest students.[8]

Personal attention is vital to the intellectual development of students, but many face limited access to their teachers and fail to receive the intellectual support they need. Only a few universities can offer the one-to-one and direct personal teaching that allows academics to diagnose and formulate the best course of study for an individual student. In the United States, those students who are lucky enough to attend a university or college with small classes will face the prospect of enormous fees, often leading to a lifetime of debt.[9]

Students today have access to a bewildering variety of free educational resources, which are greater in number and variety than anything seen before in human history – colossal public research libraries, digitised libraries and manuscripts, Massive Open Online Courses, podcasts, online encyclopaedias, and YouTube videos. Online data flows continue to increase in volume and global reach.

A library of resources cannot, by itself, supply a university education. Students face an overwhelming amount of information. Woolf acknowledges the dangers and opportunities of this context. What is required is the sound judgment and personal accountability from teachers with the wisdom to chart a path across an ocean of choices. It is the oldest form of teaching – personal instruction – which will allow the proliferation of information to have a transformative and beneficial impact on the educational experience.

2.2.3 The Consequences for Society

Universities are an essential tool for the creation and transfer of knowledge. They are a key element in the organisation of human civilisation, and they are engines of human progress. A prehistoric human with a modern education could do everything a modern person could do, which is to say that millennia of human learning and advancement are encapsulated in our systems of education. Any improvement to these systems at a global level is of serious consequence for the future of humanity.

Although Woolf is not perfect, we believe it will be more perfect than the current system. The system we propose has the flexibility to allow for growth and improvement, and it has mechanisms to accelerate and adopt improvements as they are proposed and developed. It will replace a badly coordinated marketplace with hidden criteria, perverse incentives, and damaging personal effects, with a more

[8] https://www.cnbc.com/2017/06/21/jack-ma-this-is-what-to-study-if-you-want-a-good-job-in-the-future.html

[9] https://www.chronicle.com/article/Who-Has-the-Most-Student-Debt-/242316?cid=wcontentlist_hp_latest , https://www.chronicle.com/article/Economists-Offer/237906

transparent market of delineated criteria, a plurality of options, and secure contracts which build demonstrable track-records of success for students and teachers alike.

3. The Woolf University Solution

As the first blockchain university, Woolf will use new technologies to reimagine how students can connect with professors in a personal but geographically agnostic manner. This allows any student with access to a smartphone or computer to have access to a world-class education, no matter where they are in the world. But at its core, Woolf makes possible one of the oldest ways that human beings really learn, which is through individual teaching and instruction. Such instruction simply cannot be provided by a bureaucratic system or a podcast or a MOOC or a book – although these are all potentially important.

Woolf uses novel forms of organisation to support the most traditional kind of teaching, namely, one-to-one and one-to-two Oxbridge-style tutorials in which teachers come to understand the intellectual needs of their students, and students can be given an academic apprenticeship in thinking.

3.1 The Timeliness of the Solution

Woolf University is the future of education. It is designed to be resilient to the exponential trajectories of change that we have seen over the last decade in markets from manufacturing to law, markets in which humans have been replaced with robots, and human knowledge replaced by artificial intelligence.[10]

Blockchain networks now make available unprecedented forms of decentralised organisation, in which 'trustless' smart contracts and democratic procedures give participants the protection and confidence to become active members. The smart contracts which Woolf intends to deploy are meant to make increasingly obsolete key administrative tasks which currently act to raise tuition fees for students and lower salaries for teachers. The underlying technology of Woolf University makes it possible for students and teachers to connect directly.

Universities are complex societies. Not every aspect of a university education can be codified – and this is why the core offering of Woolf University is an education built upon unscripted direct tutorials in which teachers and students connect. We view this as a robot-resistant education, training students to think creatively and independently.

However, many aspects of a university can be codified, and doing so with a blockchain has numerous benefits, including transparency, opportunities for deliberative reflection, democratic oversight, contractual security, and the high levels of efficiency which allow professors and students to concentrate on their core mission.

[10] Kiran Stacey and Anna Nicolau, 'Stitched up by robots: the threat to emerging economies' Financial Times 18 July 2017; Michael Pooler, 'Robot army is transforming the global workplace' Financial Times 20 November 2017; 'Towards a Reskilling Revolution: A Future of Jobs for All' World Economic Forum January 2018; Carl Benedikt Frey and Michael A. Osborne, 'The Future of Employment: How Susceptible are Jobs to Computerisation?' The Oxford Martin School 17 September 2013.

3.2 The Novelty of the Solution

As the first borderless blockchain university with smart contracts, Woolf aims to transform the way humans educate themselves even while recognising the human need for personal instruction. Never before in human history has it been possible to connect people all over the globe using a few common languages. Never before has the technological infrastructure on which Woolf relies been possible or so widely distributed. Never before have so many educational resources been made available to the public without cost.

Today, students and educators are locked within institutional and geographical silos. Woolf University aims to remove those silos and allows students to connect directly with experts, no matter their location or institutional affiliation. Woolf is not like other digital universities or learning platforms, nor does it seek to compete directly with them. Woolf simply uses digital technologies to reimagine how traditional forms of education can be sustained in a geographically agnostic manner.

Online education today consists of massive open online courses, clunky digital classrooms, multiple-choice tests, and box-ticking exercises. Online universities consistently fail to garner public respect, and often display a stunning failure of pedagogical ambition. In part, this is because they so often violate an essential core of human education, which is personal interaction.

What Woolf offers is different: students attend tutorials. These can be online, which is useful if the professor is in another location, or they can be face-to-face. In either case, both parties 'check-in' to the tutorial on the blockchain. Woolf is not an online university; it is simply organised online. Tutorials provide direct and personal interaction with an expert academic. Most tutorials consist of an hour-long discussion of a student's essay, and the assignment of another essay for the following week.

Tutorials are a time of thought-provoking discussion, sometimes even disagreement, in which a student is taken seriously and the student's opinions are valued and tested. Sometimes they are as simple as feedback on the student's essay; sometimes they are intellectually demanding, but they always require dialogue and they always help to cultivate agility of thought. Tutorials require original thinking rather than the mere recitation of material; they train students with the skills of pattern-recognition and improvisational problem solving needed in a world of increased automation.[11] Tutorials are the essential building block of the Woolf educational system, just as they are at the universities of Oxford and Cambridge. Students always study under the supervision of a tutor, and students may have many tutors over the course of their studies.

Students must learn to read their assigned texts with care, compose essays, and explain their views to a professor. Pedagogical discussion is vital and typically conducted in person or over a platform like Skype. Tutorials begin when both parties confirm on the blockchain that the tutorial has begun. We intend for this to be as easy

[11] http://www.businessinsider.com/mark-cuban-liberal-arts-is-the-future-2017-2

as pushing a button on the Woolf app, which will automatically transfer the student's payment into the teacher's account and confers course credit to the student's indelible record on the blockchain (without revealing the student's personal data). It is the most basic interaction in the Woolf network, and can be conducted without respect to geography (4.4 'Check-In').

There are a number of online course providers, including D2L, Alison, P2PU, Khan Academy, Udemy and Udacity – some of these are meant to be very profitable businesses. These are the Walmarts of the online educational space. Woolf is not a competitor with these types of institutions.

Woolf is not a competitor because it is not an online university; it is simply geographically agnostic and medium agnostic. It is not a competitor because it is a non-profit, democratic, decentralised society. And it is not a competitor because it seeks to support the world's very finest academics and connect them to the world's very brightest students in one-to-one instruction.[12] Colleges on the platform compete with each other, and not all colleges will be the best, but Woolf University is designed to attract the best. Lower fees do not mean lower standards – Woolf will seek to attract the brightest students.

When it comes to online teaching, it is notable that much of it has become almost entirely automated. Our general position is to apply the robot test: *if robots could successfully run such a class, and if robots could pass all the tests, then we probably have a problem*. Our strategy is to concentrate our energy on those areas where humans can outperform robots. Let the blockchain do what the robots can do. The personal tutorial system is a form of intellectual apprenticeship that cannot be conducted by robots.

There are a number of software services for online course management, including Blackboard, Moodle, Instructure, and Sakai. Universities use these to supplement their administrative processes when managing large classrooms – they can organize course enrolment, grade submissions, and they can be used to cross-over into online instruction through the use of tools like chat rooms. To some extent these tools try to solve problems which Woolf does not have, like the need to manufacture 'interactions' between several hundred attendees of a lecture course. To the extent that these tools reduce bureaucratic experiences and administrative overheads, we applaud them.

Woolf, like an Amazon or Airbnb or Uber, is not simply a piece of enterprise level software. What these companies provide are new economic realities. Any of these companies could pay for enterprise software and still succeed, just like Woolf University could pay for Blackboard and still succeed.

Woolf creates new economic and social relations within the framework of a blockchain. We believe this is essential because we believe that the values to be encoded in the

[12] Anyone can join the University and take classes from the tuition bidding pool, but colleges retain the right to select their own students and compete for excellence (7.5.1 The Tuition Bidding Pool, and 6.3.3 College Admissions).

Woolf blockchain – humane, democratic, and ultimately non-profit values – are crucial to the future of the university.

The fiscal soundness of Woolf is discussed in 8. Revenue and WOOLF Valuation, where we offer our best analysis of the economic stability and success of the enterprise.

3.3 The Urgency of the Solution

The first blockchain university will have the first-mover advantage. We believe that the group of talented educators that Woolf has attracted, and the democratic, decentralised, non-profit principles it seeks to encode, will make Woolf superior to the potential alternatives and better for the future of humanity.

It is thus urgent that the Woolf token offering and media campaign begin as soon as possible, and be conducted in a professional, orderly, and honest manner. We believe in the democratic, credible, and public-spirited values to be offered in our platform as having the potential to significantly alter the course of human education. If the first-mover advantage is not secured, a less democratic, less credible, less charitable alternative may come to dominate the sector and ultimately provide less of a benefit to society.

Moreover, we expect market token offerings to peak soon, if they have not yet peaked already; we worry that their peak will signal market saturation and an exhaustion of capital for projects of high significance. These are reasons for our speed to market. Yet we remain optimistic that the superior characteristics of Woolf, including the possibility of its long-term revenue stream, will make it stand out from the competition, shifting capital from weaker, more frivolous blockchain projects to the Woolf University project.

4. The WOOLF Utility Token

The blockchain network of Woolf has its own utility token, WOOLF.

At the time of writing, cryptographic tokens or 'currencies' have a market capitalisation of $462bn, with the top 28 currencies capitalised over $1bn, and the top 5 capitalised over $10bn. More than 220 tokens are capitalised above $50m.[13] We believe that the blockchain market will consolidate around the most credible projects, and that Woolf is designed to fare well during this process, but its success as a utility token depends upon factors beyond our managerial control. This is not intended as investment advice. Readers should do their own research and consult with a certified financial advisor.

WOOLF is the service medium for exchange relations in a decentralised market. The link between smart contracts and the utility token acts to ensure that all parties fulfil their contractual obligations. In the first instance, that is the obligation for contracted teachers and students to undertake their tutorials, but it also includes administrative

[13] https://coinmarketcap.com/all/views/all/

processes like the automatic deduction of overhead costs, and teachers in some jurisdictions may eventually have their taxes automatically calculated and deducted.

4.1 The WOOLF Protocol

We are releasing an ERC20 token on the Ethereum network, and we will use 'smart contracts' written in solidity for the Ethereum network.

In fact, Woolf is not finally committed to Ethereum as a long-term underlying platform. The developers of the Woolf network are committed to working with the very best blockchain platforms and hiring the very best software architects and blockchain developers. We place a high value on user experience and we are sensitive to user costs. Given the rapid pace of blockchain coding advancements, particularly in the area of interoperability and smart contracts, our underlying code may change as the network matures, and we intend for our network and its native token to outlast any underlying code. We have thus outlined a strategy for managing any need arising which might move us off of the Ethereum network, and this can be read in 6.1 The Woolf Reserve.

4.3 WOOLF in Practice

In the first instance, anyone holding WOOLF tokens could use them in a mature Woolf network to check-in to a tutorial and receive credit for their studies. It would not directly matter how the tokens were acquired. As a utility service with smart contracts, the network itself would be fully functional without a fiat currency interface, since one could buy and sell the tokens on a secondary market. The network can be launched and successfully run without a fiat currency interface.

The interface between the WOOLF token and fiat currencies presents future challenges and opportunities. In the first instance we are bound to the laws of Gibraltar, and during the earliest phase of network development, we will not need to adopt the DLT Framework.

We recognise that network adoption will be improved if users can send and receive money in their own fiat currency of choice. We prize a student experience free of any cumbersome technological processes. For example, it would be desirable if a student could pay in fiat currency A and the teacher could receive fiat currency B; traditional financial services make this possible for businesses like Airbnb, and users now expect this convenience in many internet marketplaces. Our roadmap of network improvements includes milestones like fiat currency integration. As the network develops, more of these milestones will be subject to democratic approval. Any fiat integration would need to take into account token velocity.

Fiat integration has implications for the structure and complexity of the WOOLF smart contracts, which may stipulate a delay between contractual start and contractual conclusion, or may contain provisions for a refund. On the Woolf network, all transactions are conducted in the native WOOLF token. If the utility token is initially purchased with a student's fiat currency A, and much later redeemed in the teacher's fiat currency B, then the college or university potentially becomes a bearer of risks while holding the fiat currency. Such a scenario arises if the rate of exchange across

three ‘currencies’ is fixed by the smart contract, but the option of a refund remains open, and thus the final direction of exchange uncertain.

For example, an Indian student commits to a course of study, using INR to buy WOOLF, but the teacher cannot receive the contracted payments in USD until the appropriate conditions have been met many months later (e.g. holding the tutorial at the end of term). To secure the rate of exchange, the college’s smart contract has automatically purchased the teacher’s USD, but then the teacher fails to deliver, and the college must change the USD for INR at a loss, since the smart contract guarantees the full delivery of INR back to the student and automatically deducts from the college accordingly.

In such cases, small colleges may bear an undesirable amount of risk from currency fluctuations since (1) smart contracts entailing refunds (such as when a teacher fails to check-in for a tutorial) mean that the college cannot secure the necessary exchange rate in advance with complete confidence, since it is unknown which currency will finally be purchased and (2) the native token is likely to fluctuate against fiat currencies, especially while the network is growing, and thus the financial standing of the college holding any currency might be weakened.

Until these problems receive adequate solutions, the network will only recognise WOOLF tokens. Democratically allocated funds will be proposed for network development projects like fiat currency exchange. Two intermediary solutions can be suggested while waiting for this developmental work. First, we will seek to partner with a financial technology company like Revolut (or Transferwise or Bitcoin Suisse) to outsource fiat currency transactions and improve user experience. Revolut already offers services – including fiat-Ethereum integration – which closely match our requirements for a low cost.

Second, we propose allowing smart contract refunds only in the native token, even if token exchange rates are fixed against a teacher’s pay in fiat. This reduces the complexity of the risks for the network and eases the integration with fiat payments. It is a viable solution because bona fide students in receipt of a refund are still seeking tuition and require more WOOLF to achieve whatever progress their initial investment was meant to secure, such as another tutorial hour, to which they are bound by a smart contract. If the college remains contractually obliged to pay out the teacher’s final salary in a fixed amount of fiat currency, then its initial (hedge) exchange remains valid.

Limit cases would remain, such as the death or absence of a teacher requiring the student’s tuition to be provided by another college, but such cases are significantly less probable and less complex to manage. For example, the student’s refunded WOOLF could be more valuable in the tuition bidding pool than at the college (7.5.1 The Tuition Bidding Pool). Such risks further incentivise colleges to admit only reliable teachers, and a college’s smart contract can protect its reputation with fines or expulsion for delinquent teachers.

Student reliability is incentivised from the start, since a college charges a student for future tutorials and refunds are only possible if the teacher, rather than the student, fails to check-in for a tutorial. Student reliability tends to increase over time, since students have both their identities and their accomplishments associated on the blockchain. It becomes increasingly prohibitive for any student to start a new identity because their indelible record of study progress is tied to the user identity.

As the network grows and matures in its operational diversity, we hope a decreasing number of academics on the platform will exit the utility token when receiving their salary; this is for a variety of reasons, including the value of WOOLF to university-wide administrative tasks and because future faculty members may democratically elect to organise separate college pension schemes involving the utility token. Further, we expect (but do not promise or advise) that global rates of adoption for the utility token could grow over the next decade, which could entail inflows of fiat currency from students causing the native token to appreciate. (Purchasing tokens is risky and only adults with good financial advice and an understanding of the risks should do so.)

4.4 The Case for Utility: The Tutorial 'Check-In'

The first and most basic transaction on the Woolf network is the 'check-in' for a tutorial. This transaction supports the most fundamental relationship in the network. When both parties check-in to the tutorial, they agree that it has begun. This executes the smart contract: the teacher is paid for an hour of tuition and the student is indelibly recorded as receiving academic credit for the tutorial.

Woolf University is geographically agnostic and medium agnostic. A student and teacher might 'check-in' when starting a discussion over Skype or when meeting in person. The smart contract might delineate the terms of the meeting, such as date, time-zone, and timeframe. The use of APIs could make it increasingly possible to include proof of fulfilling further terms, such as location data, or the effort to connect over a delineated platform like Skype. If a tutorial has been convened to discuss an essay, a submission deadline could be included in the smart contract. The stipulations of a smart contract are a matter of college policy, and not only a matter of technological improvements to the network. The 'check-in' itself is sufficient to provide proof of agreement and payment for a single hour of instruction, regardless of whether this is embedded within a larger network of smart contracts, including contracts showing progress towards a degree.

The most basic utility of the Woolf network may be as simple as two people clicking a button on the platform application. Without any further smart contract stipulations, this shows the minimum utility of the Woolf network, but we aim to see a network built with the potential to develop far beyond that core utility, a network with the institutional pillars that will allow it to become a global platform for organising human education. We identify minimum utility as the first milestone in the development of the network, and we define the minimum satisfactory utility of the network as (1) a network which can facilitate a basic version of the check-in procedure, (2) a network with the potential for further development because of a democratic governance mechanism for allocating WOOLF to development projects, and (3) a network which counts excellent academics as registered members.

Although it might seem odd, at first, for a professor and student to look at their phones and digitally agree to start a meeting, doing so could eliminate a host of salaried administrators and provides both parties with a range of security assurances. We hope this will become the normal procedure in all university education.

4.5 Token Utility and Legal Regulation

Woolf Development has chosen to incorporate in Gibraltar because the legal framework is clear and provides a secure environment for blockchain technology. Woolf Development seeks to act within the laws of Gibraltar, in which the Judicial Committee of the Privy Council in London is the final court of appeal. (5. Legal Entities).

In the current regulatory environment, all 'Initial Coin Offerings' or 'Token Generating Events' face uncertainty in the United States where they may fall afoul of stated or unstated SEC regulations. Until the US legal definition of a security is clarified with respect to a utility token like WOOLF, adequate effort will be made to prevent US citizens from purchasing tokens at the token sale. Adequate effort is here defined by a partnership with a KYC service provider who will check the identities of purchases to ensure that they are not US citizens. Purchasers agree to attest to the fact that they are not US citizens and agree that they are not purchasing securities.

In 5. Legal Entities we describe a distributed legal framework for the future operations of the network, which will disperse managerial efforts. This entails a distinct, non-profit company or trust to be established after the token sale, in order to supply improvements to the network over the long-term. In 6. Network Entities we describe democratic procedures that also disperse managerial judgments. Given the role of 'managerial control' in US law, it may be notable that aspects of the future development of the network will be outside of our managerial responsibility as members of Woolf Development.

Utility in a token is not bound to a single software protocol. Nothing prevents a token from having its underlying code swapped if a superior protocol will enhance utility for the network – for example, two tokens recently announced a move from Ethereum to Stellar. Whether such underlying changes in the coding amount to an 'exchange' of tokens will pass entirely unnoticed to most users, for whom it is little different than updating computer software; what is potentially noticed is an enhanced utility. The current generation of students is composed of 'technical natives' and they expect improvements to user experience to be continuous. Woolf Development cannot predict whether any underlying code will be final, since the democratic consensus of the University network can stipulate a change to the code, create a fork in the network, or may adopt novel suggestions from examiners of the open-source software.

We believe there to be a public good at stake in the effort to build the first blockchain university, Woolf University, and given the urgency of achieving a first-mover advantage, it is our hope that a speedy release of the WOOLF token in a legally transparent and sound environment like Gibraltar will protect all parties.

5. Legal Entities

There will be two main legal entities: Woolf Development and The Woolf Trust. These are not to be confused with the technologies that support and are supported by these institutions, like the WOOLF token or the Woolf blockchain network which may be colloquially referred to as 'Woolf University'.

It is an open question whether any legal status should be sought for an entity called Woolf University, but a committee will be proposed to identify the jurisdiction(s) in which Woolf University degrees may best be issued (7.3 University and College Awards). (If it is deemed appropriate by legal council, and with the democratic consensus of the faculty members of the network, the Woolf Trust may ultimately be renamed Woolf University.)

Each college that is formed on the blockchain network may seek its own legal incorporation, in order to issue its own legally recognised degrees above and beyond any blockchain degrees. The legal status of the colleges on the Woolf network is of no direct interest to the network or Woolf Development or the Woolf Trust; it remains a matter of their domestic jurisdiction. Pre-existing educational organisations, with their own independent legal status, from any jurisdiction, will be invited to form colleges on the network, provided they adapt to its rules.

Woolf Development is an entity established to launch the Woolf blockchain network. It will be the issuer of the tokens at the token sale, and it will be a partial recipient of their proceeds, which will be dedicated to software development, paying the founders, and paying the salaries of the retained faculty members (10.2 Proceeds from the Token Sale). The structure of payments (which may pass partially through the Woolf Trust) will be subject to legal council.

5.1 The Formation of the Legal Entities

Woolf Development Ltd is the Gibraltar company which is responsible for the token sale and network launch. After a period of 18 months, pending legal council and a simple majority consensus of the network faculty members, and in no case longer than 4 years, Woolf Development will hand all managerial control to the non-profit company, The Woolf Trust. In no case will Woolf Development exercise any authority over the network after 4 years.

The Woolf Trust will be subject to democratic procedures and bound to fulfil its non-profit mission of developing the Woolf network. The legal council of Woolf Development will draft the bylaws of the Woolf Trust, and the first members of the Board of the Woolf Trust will be both nominated and elected by the academic members of the Woolf network. The Board may assign the implementation of its responsibilities to various committees or third parties, and in exceptional cases a faculty vote in the Council may veto these assignments (7.1 The Faculty Council).

If the University Council so chooses, Woolf Development may continue to act as an assignee of development tasks under the authority of The Woolf Trust, but it will have no managerial authority in its own right.

Woolf Development is not responsible for future actions undertaken by the Woolf Trust because the Trust is subject to the democratic will of the network's faculty members in the University Council. Once managerial responsibility has been passed over to the Woolf Trust, it is the managerial direction of the Trust, and ultimately the democratic consensus mechanisms of the University itself, that are responsible for improvements to the Woolf network.

5.2 Woolf Development

Woolf Development is guided by the core leadership team, the advisory board, and the academic advisors. The members of Woolf Development are shown on the website (woolf.university) and their profiles can be seen in a separate document.

The Academic Advisors consist of a group of experienced academics, mostly with an Oxford background, who will help to develop the first college of Woolf University. Funds for the activities of Woolf Development have been loaned from its founding director and will be raised in the token sale. The allocation of those funds is described in 10. Token Allocation and Token Sale. The Faculty members may vote, as described in 7.2 The Monthly Budget Vote, to allocate monthly token budgets to the activities of Woolf Trust with Woolf Development as an assignee of the Trust. All activities are subject to funding.

The core leadership team of Woolf Development will be responsible for hiring or subcontracting more UI/UX software developers, blockchain engineers, media specialists, and legal council. The core leadership team will cultivate its strong connections with existing educational institutions in order to foster good working relations over the coming years. The core leadership team will work with our legal council and liaise with the academic advisors.

The academic advisors are retained to form the membership of the first college on the network. The responsibilities of the academics during their paid tenure consist of (1) maintaining their world-leading reputations through research, (2) designing the course structure for the first college, (3) liaising with the software development team, and (4) potentially appearing in material for the media team. (5) The academic advisors will be invited to nominate senior advisors to Woolf Development, with significant institutional or government experience, who may later take up roles in the first college or the Woolf Trust.

(6) Each academic advisor will produce 8 lectures to complement an 8-week tutorial paper; these will be video taped or recorded at the college's expense and made available to the public at no cost. These will serve to reinforce the course offerings of the first college and to promote the academic profile of the University and the first college.

(7) The Academic Advisors will ensure that core academic standards are formulated for the platform, including transparent procedures for pastoral support, disciplinary problems, and student grades.

5.3 The Woolf Trust

The Woolf Trust will be the annually audited, purpose defined, non-profit entity tasked with managing the endowment of the Woolf network on behalf of its faculty members. It is responsible for funding and prosecuting special projects determined by democratic procedures of the Woolf University Council (7.1 The Faculty Council). It will be one of the largest holders of WOOLF tokens and the financial skills of its fund managers will make possible essential projects for the university.

The Woolf Trust will also provide the legal framework for the Woolf Reserve, which funds the regular monthly budget. The Woolf Reserve is a smart contract on the Woolf network which only emits tokens for the budget at an algorithmically predetermined rate of 0.035%. The funds are otherwise locked. The smart contract dictates the terms of the Reserve and the Woolf Trust is not otherwise able to manage or access the funds. The Woolf Trust cannot, for instance, use the funds for a project, but must rely upon the funds under the managerial control of the Woolf Trust. This is described in 6.1 The Woolf Reserve.

The Woolf Trust will have the authority to implement (but not to fund) any of the monthly budgetary items assigned to it in the regular faculty vote, and it may assign these projects however it wishes. Such budgetary items are funded by the Woolf Reserve. This is described in 7.2 The Monthly Budget Vote.

The Woolf Trust is subject to the democratic will of the Faculty members of Woolf University, which can democratically veto the Trust's on-going projects, seek a quorum for voting on new projects, and vote to fund projects with the assets of the Woolf Trust. Smart contracts will facilitate these activities when possible. The general tasks of the Woolf Trust are described below.

Perpetual Blockchain Development. The chief project of the Woolf Trust is the perpetual improvement of the underlying blockchain network of Woolf University. The chief aim of improvement is the reduction of administrative staffs through increasingly sophisticated smart contracts and the ease of user experience. The first projects to be addressed are the core university processes outlined in 7. University Processes.

General Software Maintenance. The on-going responsibility of the Trust includes general costs of network-wide non-blockchain software maintenance, including servers for user-facing websites and apps.

Verification. The Trust will conduct or outsource document verification processes on behalf of new faculty members, students, or administrators.

On-boarding. The Trust will provide an advisory task force to help existing educational institutions that wish to join Woolf as 'colleges'. This will help them adapt their social practices to comply with the smart contracts of the Woolf network. We foresee many of these helpful insights being conveyed through a few educational videos, which the Trust will be tasked with overseeing.

Administration. The Trust will fund, subject to annual University approval, several administrators for University business and any compensation deemed necessary by the university for the board members of the Trust.

Media. The Trust will handle all University media enquiries and fund a media team to promote the interests of the University.

Fund management. As one of the largest holders of WOOLF in the world, the Trust has the opportunity to secure the long-term interests of the University through sound practices of fund management. The trust will be charged with protecting and developing the assets of the trust on behalf of the University and all of its members.

6. Network Entities

Network entities are groups hosted on the blockchain and represented on the Woolf websites and apps. These are digitally organised and may or may not have any separate physical or legal standing.

6.1 The Woolf Reserve

The authors of this paper, as members of one of the world's oldest universities, are aware of the need to plan for the long term. The Woolf Reserve is designed to strengthen the development of the University over the next century and beyond, and it will prepare the university for unexpected challenges. The Woolf Reserve is a simple but powerful tool consisting of a smart contract that emits tokens slowly over time for projects that increase the value of the network.

The Woolf Reserve has two missions.

6.1.1 The Woolf Reserve Emissions Rate

The first mission of the Woolf Reserve is to protect the value of WOOLF by relying on a slow emissions policy, even while funding monthly budgetary needs over the long-term. As a community we have considered and rejected other strategies of token distribution, which we view as wastefully inflationary. The Woolf Reserve makes tokens available only for projects that improve the network and thus potentially add value to it. Tokens are made available at a predictable, steady, and conservative pace. Unused tokens are simply returned to the Reserve. No new tokens are created.

It is essential that the Reserve be not confused with the funds available to the Woolf Trust. The Woolf Trust is the legal guardian of the Reserve. The Woolf Trust cannot trade, or invest, or in any way use the funds held in the Reserve. The Woolf Trust can unlock the Reserve under a single condition, described below.

The function of the Reserve is to automatically make available at the end of every month 0.035% of the Reserve for development projects. Development projects are suggested by the community and selected by a democratic procedure (7.2 The Monthly University Budget). Democratically successful projects, meeting the consensus threshold, are directly funded in the order of their consensus ranking until

the monthly budget is exhausted. Faculty membership is required to vote. The monthly budget, issued by the Reserve, will be the responsibility of Woolf Development until the voting system can be implemented and authority passed on to the Woolf Trust under the management of the Faculty.

The bylaws of the Woolf Trust, and the smart contract of The Woolf Reserve, stipulate that no authority, including the University Council, can increase the emissions rate of the Reserve above $0.09\overline{9}\%$. In other words, the reserve may only ever emit tokens at a monthly rate below one tenth of one per cent. At this rate token meaningful emissions will continue for centuries.

6.1.2 The Woolf Reserve Mining Policy

The second mission of the Woolf Reserve exists to prepare the network for the possibility of financing its own mining in the unlikely eventuality that there is a problem with the Ethereum network. This is the single condition under which the Woolf Trust may unlock the Reserve to release its funds.

The mission of the University cannot be hampered by problems arising from any underlying network, and although the pace of improvements with the Ethereum network have been encouraging (e.g. the Raiden network and the upcoming Casper implementation), we recognise that Woolf may need to develop its own mining operation, or move 'on top' of another network, such as Stellar. We hope to work with the Ethereum Foundation to avoid any such eventualities, but the good of the University and its members must prevail in any decision making process. We thus reserve funds for a mining operation.

If the Woolf network undertook its own mining operation, funds in the Reserve will be reallocated as mining rewards. The overall number of tokens in circulation at the time of the mining operation's commencement, and the overall number of potential tokens which might enter circulation in future, would remain fixed. The allocation of budgetary needs would also remain constant, but would now be drawn from a smaller Reserve, or would reflect a percentage of the mining block rewards accumulated in a superblock at the end of the month, and allocated to the budget. (This has been successfully practised by a number of networks including Dash and Pivx.)

Naturally, the increased rate of inflation required to pay for proof-of-work mining would be avoided at all costs in favour of proof-of-stake mining, but even the introduction of POS mining would constitute an increase in inflation compared to the existing budgetary system. A number of strategies could be used to offset that increase. For example, the reduction in network transaction fees, which would result from a move off of the Ethereum network (in which payments are made for the underlying network gas), could provide a surplus to be partially re-allocated to fund the Woolf Reserve and offset the cost of POS mining. It remains, however, that even a significant reduction of 50% of the Reserve would still see it capable of effectively funding development projects over the next century if the market value of Woolf remains in line with our assessments.

The Woolf Reserve cannot be used for any other purpose. During the phase in which Woolf Development retains managerial control, any move from the Ethereum network to a native network, or to another network (like Stellar) will require the approval of the Trustees of the Woolf Trust, including the legal council of the Trust which guards the Trust's bylaws. Once authority has been passed from Woolf Development to The Woolf Trust, the move will be made solely at the directive of the University Council and implemented by the Trust within the constraints of the Trust's bylaws.

6.1.3 Justification for the Woolf Reserve Strategy

We believe the current strategy of launching on top of Ethereum with The Woolf Reserve and a conservative emissions rate is the best strategy for Woolf University for the following reasons:

1. Ethereum is sufficiently fast to manage the transactions described in this white paper.

2. Ethereum makes available the smart contracts we need to run almost all of the processes described in the white paper. This will allow us to get up to scale in the most orderly and rapid manner possible, by using and revising tested, open-source code.

3. Ethereum is sufficiently cheap that it does not yet make economic sense to run our own mining operation on our own native network. As a service provider, Ethereum offers us the advantages of a global blockchain, allowing us to achieve distributed cryptographic security, from the first day of operation.

4. It is better to start on Ethereum and move once the network scales. By starting on Ethereum, we can confirm network transactions with Ethereum's globally distributed mining operation, even though we may, at first, have only a few colleges and dozens of faculty members. The extent to which the Woolf Network grows and encounters the limitations of the Ethereum network is also the extent to which the Woolf Network can justify the security of its own proof-of-stake mining operation, in which colleges compose the core network of POS verifiers on its own native blockchain. If colleges were to become the sole verifiers of transactions in a mature and highly saturated network, then even a non-profit or loss-making verification (though this would be unnecessary) could remain incentivised, since colleges require a functioning network to operate.

Some ERC20 token networks might be tempted to distribute ERC20 tokens to Ethereum miners, but our assessment is that this amounts to unnecessary inflation, since we will already pay Ethereum gas for *all of the work* done on our behalf by the underlying Ethereum miners. It thus amounts to little more than a token airdrop. We believe that the WOOLF tokens should be provided for improvements to the network, so that inflation is pegged to increased value. Mining is a valuable network contribution, and proof-of-work mining is expensive, but since we already pay for Ethereum's POW mining through WOOLF transaction fees, there is little reason to simulate other forms of token emissions.

Our solution is thus simple and clear. Token emissions are set at 0.035% of the Woolf Reserve on a monthly basis for the budget. Democratic procedures determine the allocation of the monthly budget for development projects to improve the network. Mining on a native network only commences if there is a direct advantage to the users of the network. Inflation is pegged to network improvements.

6.2 Woolf University

Woolf University is the network composed of all the colleges and their members. Colleges are composed of faculty, who alone are eligible to teach; students, who are not eligible to teach without becoming full faculty members; and administrators.

There are no faculty members of Woolf University who are not members of a college. The Woolf Trust is assigned the task of validating the identities, certificates, or other criteria of new faculty members, but it cannot otherwise bar the entry of eligible faculty members. The University itself does not admit individual faculty members, but anyone with valid documents meeting the requisite criteria may start their own college on the network platform. Criteria for college formation and faculty membership are subject to democratic consensus (7.1 The Faculty Council).

Colleges are selective, but the University is not. Any student can join the University free of charge before being admitted to a college, for example, to find a single class in the Tuition Bidding Pool (7.5.1 The Tuition Bidding Pool).

Any student admitted to a college for a course of study is automatically a member of the University. College admissions are at the discretion of the colleges, and systems throughout the university will incentivise honesty (e.g. 7.4 The Class Run-Off Process). Only students who are admitted to a college can study for a degree course, and under certain conditions, credit will accrue to their college course even when earned outside their home college (viz. in the Tuition Bidding Pool).

Woolf University will seek to be administered entirely by smart contracts hosted on a blockchain. It aims ultimately to have an administrative staff of zero. It may be many years before The Woolf Trust succeeds in making this possible, or it may ultimately be found undesirable. Until then, The Woolf Trust will supply a minimal administrative staff on behalf of the University, with a limited mandate. Administrative tasks within a college are the responsibility of a college. An administrator can be hired, or an eligible task can be put out to bid (7.5.2 The Administrative Bidding Pool).

6.3 The Colleges of Woolf University

University rules constrain the formation of colleges. A quorum of 30 faculty members must be achieved for a college to be formed. There is no limit to the number of colleges in Woolf University. The default University cap on the total number of faculty members allowed in a college is 10,000.

The first 5 colleges of Woolf University require 80% of the faculty members to hold research doctorates issued by the top 200 universities in The Times Higher Education,

'World University Rankings 2017'.[14] There is no limit to the number of students they admit or administrators they can hire, though smart contracts will prevent them from overextending themselves (e.g. by double booking tutorials).

All new colleges will have to accept The College Template of internal college rules, although they may vote to change any of these rules by democratic consensus at their first meeting or at any later meeting. As noted above, the architecture of the Woolf platform consists of the University's network-wide rules that constrain all network processes including internal college rules, and college-specific rules that only constrain their members. By itself, a college cannot change the rules of the whole network, including University rules that constrain colleges, unless that college's members form an 81% majority on the University network (7.1 The Faculty Council).

At the moment of their formation, each of the first 5 colleges of Woolf University will be endowed by the Woolf Trust in WOOLF. These funds will be locked in unique smart contracts and disbursable only through the tutorial 'check-in'. This will make it possible to provide student scholarships and thereby extend the reach of Woolf to the best students in the world, regardless of their financial circumstances. This is especially relevant in countries where Woolf University or its college has not yet secured adequate legal recognition for its students to qualify for state aid, or in those countries where such aid does not exist. It is especially valuable during the early stages of the University's growth.

6.3.1 The College Template

Like hosting a property on Airbnb, or becoming a driver for Uber, we want starting a new college to be a painless process. No permission is required to start a new college provided that the minimum criteria have been certifiably met. Starting a college should demand equal or less bureaucratic work compared, for instance, to organising an academic conference. Unlike Uber, however, smart contracts will protect college members and provide greater predictability and stability of employment.

Like hosting a property on Airbnb, the College Template consists of a scalable website interface for the underlying blockchain and it smart contracts. The template allows a faculty group to upload their own profiles and course offerings, and will present students with an attractive and organised site to explore the college in a visual layout that is familiar across the University. This is typical of any major scalable website like Facebook or Amazon, and it has been practised effectively in a university context at Cambridge, using Plone for their Falcon Content Management Services (without an integrated blockchain, of course).

The College Template will be issued to any qualifying group of faculty members meeting the quorum for college formation. If a quorum of the faculty members forming the new college are already members of a Woolf college, and have thus already completed the faculty verification procedure, then the formation process will be nearly instant. Thus organic growth and cold-starts are both possible.

[14] https://www.timeshighereducation.com/world-university-rankings/2017/world-ranking#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats

The College Template contains rules that must be distinguished from the University rules that constrain all colleges. The College Template can be revised by colleges as they see fit, but University rules which apply to college activities require a University majority for revision. Details of a college template can be seen in the case of the first college of Woolf University, Ambrose (6.3.2 Ambrose). The Academic Advisors to Woolf Development will draft the full template and work with the blockchain engineers to integrate it with the blockchain's smart contracts.

Forming a new college would be even more attractive once the Woolf University degrees become recognised as a global standard. Academics will more eagerly form a college if they believe their students can meet University degree standards, and students will more eagerly study at a college that can meet Woolf University's degree criteria. The acceleration of such processes is independent of their legal recognition in local jurisdictions. (7.3 University and College Awards.)

Colleges in Woolf University, which may be existing educational establishments, can elect to continue using their unique marking schemes. However, all student performance, though anonymized, is public on the blockchain, and consensus is likely to form about how to assess student performance with a common marking scheme, or more minimally, how to convert between the 'currencies' of different grading schemes.

6.3.2 The First College: Ambrose

Our aim is for the first College of Woolf University to be formed by a group of 30 world-class teachers, experienced in tutorial education, and led by our Academic Advisors (principally composed of those trained at Oxford, and current or former faculty members from Oxford). They are experienced teaching in one-to-one and one-to-two tutorials, and they understand how to educate in an international environment. Until the formation of the first college, the Academic Advisors will be supported by Woolf Development, and their number will depend on the proceeds of the token sale. As described below, the Ambrose faculty will transition from a stipend of token sale-derived fiat, to a tuition-based salary as students join the network (10.2 Proceeds from the Token Sale).

Like at Oxford or Cambridge, the typical undergraduate coursework at Ambrose consists of writing two essays per week for three years. Each class (or 'paper') consists of one essay per week over the eight-week stretch of a term, and there are three terms per year. Each essay is discussed for an hour with a faculty member (a 'tutor'). The tutor might suggest some lectures to download, to attend locally, or to view online, but that is secondary. As with Oxford, attending lectures is advisable but not obligatory, and there is typically no credit for attendance. What students must do is learn to think well, which is accomplished through the process of writing weekly essays and discussing them with their tutor. Students are questioned in the tutorial and must think critically about what they have written, or about the assigned readings. Our approach is, in important respects, the opposite of existing online universities; there are no multiple choice tests or formulaic exercises.

Examination procedures will be a matter of college policy until the Council elects to implement any university wide examinations for specific degrees. Faculty members at Ambrose will enter a mark at the end of every tutorial, which represents both the quality of the essay and the discussion of the essay offered in the tutorial. In any 8-week course, the best 6 marks will automatically accrue to the student's record.

Ambrose will encourage its faculty to produce 8 lectures to complement their 8-week tutorial papers. The college will provide a payment of 2 tutorial hours for each lecture, and will facilitate their production. The lectures will be made publicly available on the Woolf website, Youtube, and as podcasts. This will not only be an aid for students studying a particular paper, but the lectures will also attract students to a teacher by raising its visibility, and by raising the profile of the college.

We will invite colleagues at Cambridge University to take the lead in starting the second college on the platform, and we foresee the need for a robust on-boarding team to review a high volume of student applications. The first 5 colleges of Woolf University will be endowed in WOOLF and proceeds from the token sale (6.3 The Colleges of Woolf University, 10. Token Allocation and Token Sale). These funds will be especially important in providing security to faculty members and students during a period in which the University is growing and The Bidding Pools do not yet provide the full advantages that will be available in later years. The ability to provide cost-free tuition to study with the best academics in the world will attract strong students and help the university to start on the best footing.

6.3.3 College Admissions

Student admissions to a college are at the discretion of the colleges. Anyone can join Woolf University to study in the general bidding pool or participate in the language exchange, but only colleges can admit students to a degree course.

The faculty of Ambrose are experienced in handling university admissions processes. They will make the final decisions on who is admitted to their college. Those students who meet a published set of prerequisite criteria can make an application; the strongest applicants will be invited for short interviews, and after the interviews all candidates will be notified of their status. Most degree courses request writing samples and many provide a timed essay examination.

The admission interviews are good preparation for weekly tutorials and provide both parties a sense of what it will be like to work together. Parameters for the course of study will be built into the blockchain, so students and teachers can be confident that they know exactly what they are going to get.

As the Woolf University network matures and more colleges are added, the college ranking system will be implemented (7.3 University and College Awards). This will help to clarify for students which colleges might provide more rigorous admissions policies, and which colleges might provide more lenient criteria. By first implementing a college led by world-class experts, and then by inviting our professional colleagues at Cambridge to start the second college, we aim to set a precedent of high quality in a spirit of good-natured, intercollegiate rivalry.

6.4 Student Societies

Friendships and informal discussion between students are essential to intellectual development and well-being. We recognise that many friendships formed during university studies can last a lifetime. Woolf encourages its member colleges to make provisions for student life in keeping with their educational policies and geography. Students on the same course of study should be encouraged to meet in an appropriate way, and a committee should be established for facilitating student life.

Once a student joins Woolf University, they are eligible for their first student societies. They are automatically enrolled in the local branch of the University society and their College society, and there may be a local branch of their subject area that offers membership. It may also be the case that their enrolment coincides with moving physically to a college, for those network members who choose to be geographically concentrated.

As a global network, Woolf will also aim to offer students the opportunity to meet each other, regardless of college, in their own location, and thereby form location-based student societies, reading groups, dining clubs, and so forth. With a little encouragement and support, we believe university students are mature enough to manage their own affairs like other adult members of society. We foresee a rich and varied scene of student societies with their own democratic polities developing all over the world, especially in cities.

6.5 The Language Exchange School

The Language Exchange School will allow anyone to practise a foreign language with a native speaker in exchange for acting as the native speaker in another exchange. The geographically agnostic character of Woolf University makes it ideal for language exchanges, and the use of smart contracts can give strangers the confidence to embark on a series of exchanges.

By using smart contracts, it will be possible to protect relationships without having to match exact pairs. This solves a typical problem in language exchanges.

The classic problem in a language exchange is the demand for exact matching pairs. For example: a *Native Russian Speaker*, *Seeking Native Spanish Speaker* must be matched to a *Native Spanish Speaker*, *Seeking Native Russian Speaker*. When the match is formed, the parties typically divide their time between the two languages. The problem arises when language combinations are uncommon. Although the increased liquidity of the Woolf network may diminish that problem dramatically, the use of smart contracts offers an alternative and more powerful solution.

Completing a matched pair on the Woolf network requires each party to change roles from learner to native speaker, but not within the same pair. The learner can act as native speaker with a new person. Smart contracts, and an underlying bidding system similar to that described in 7.5 The Bidding Pools, would allow for matches to be formed in complex networks of guaranteed pairs.

To guarantee the pairs, each party must place a sum of WOOLF in a smart contract which acts to protect the relationship. The full WOOLF balance (minus a small transaction fee) can then be returned to each the user once they have completed their language match commitments, i.e. once they have spoken with a native speaker and acted as a native speaker, or once they have completed the set number of such exchanges to which they have committed.

Missing a language exchange meeting, by failing the 'Check-in' agreement would automatically result in the other half of the pair receiving the smart contract funds. Thus all participants can rest assured that their time commitments will be respected, and all participants are incentivised to follow through with their commitments.

Anyone unable or unwilling to form a complete exchange match could pay directly for lessons from someone offering their services as a native speaker. Smart contracts also make available a novel alternative. If the price were lower, the learner could accept an asymmetrical match. The instant formation of an asymmetrical learner-match would mean that the learner accepts the loss of the sum of WOOLF in the smart contract; those funds would be allocated to another asymmetrical teacher-match of any kind elsewhere in the pool. Thus, a Mongolian speaker might learn Russian from a native Russian speaker who is fulfilling a teaching-obligation from her learning French. But the French teacher has accepted an asymmetrical teacher-match and gains direct WOOLF compensation. Thus the one who pays for the service, and the one who receives the funds, need not ever interact because of the novel match possibilities available to the smart contract.

The payment of non-faculty language teachers selling their services in The Language Exchange School requires democratic review. The default university-wide rule states that only faculty members can teach, that only those who are members of a college can be faculty members, and that only those with earned research doctorates may hold such faculty membership. Such an exchange would potentially pose an exception to that rule if it allowed students to pay to converse with a native speaker. Although this would not compete with the formal language instruction provided in the colleges, it should be reviewed by the University Council for approval (7.1 The Faculty Council).

The Language Exchange School is not scheduled for availability until Q3 2019 (11. Timeline) because it is not a core institution or activity of Woolf University. However, notable strategic considerations might result in an earlier development and higher prioritisation.

First, adding the School to the Woolf network may help the network get up to scale by increasing the number University users. Since anyone can join the University as a

student, without joining a college to earn a degree, the Language School would increase University membership. This could potentially increase student uptake in the colleges, and it could help those students whose linguistic skills are not yet able to meet a college's requirements.

Second, the popularity of the School may justify its early development because of the value it might add to the WOOLF token. Even if every language exchange results in the full balance of the escrowed sum being returned from the smart contract to each party, the average amount held in the smart contracts would increase the value of WOOLF. By temporarily locking value in the WOOLF currency through the smart contracts, the outflow of value from the currency is generally slowed, which would typically raise the value of WOOLF and thereby benefit to the core institutions of Woolf University. Adding value to the WOOLF token would potentially make other development projects easier since the monthly budget would itself be more valuable.

In the third place, the timing of the language exchanges need not be correlated with the timing of the regular college terms or semesters. Indeed, it may even be concentrated to times outside of the regular academic calendar and regular course delivery. Thus, The Language Exchange School would help to balance the average inflow and outflow of value across the token network throughout the year. (8. Revenue and WOOLF Valuation).

7. University Processes

We propose the following university processes for blockchain development and integration with Woolf University. Funds for development projects are to be raised in the token sale; these are partially allocated to Woolf Development for immediate work, and funds are partially allocated to the Woolf Trust for long-term development projects. Regular budgetary expenses are to be issued directly by the Woolf Reserve through a democratic process that allocates up to 0.035% of the reserve to the monthly budget (7.2 The Monthly Budget Vote).

Faculty members of Woolf University will be able to veto the Trust's projects with a Council majority, thereby denying funds to the Trust's chosen enterprise. Faculty members may seek a quorum for voting on new projects, and subsequently task the Trust with their realisation.

Although we believe that the core processes outlined below will achieve unanimous support by the faculty, it remains that these are outside of our managerial control in our capacity as members of Woolf Development and as initiators of the network. During the period of our tenure, we will seek to implement as many of these projects as possible before responsibility is passed to the Trust.

7.1 The Faculty Council

The Faculty Council is the highest authority in the University. All eligible members of the Faculty are members of the council, and no one else is a member of the Council. University governance will be conducted by digital voting in the Council. Only faculty members who have taught 8 tutorial hours for Woolf in the previous 14 months, as

recorded on the blockchain, will be eligible to vote. (This is designed to accommodate maternity leave or other circumstances).

One eligible faculty member counts for one vote. The default setting for successful votes will be 81%. Voting will be compulsory for eligible members, with fines levied in the case of failure to vote in the allotted time, unless the member is on college leave. Fines will consist of one tutorial hour of salary. Voting cannot be assigned to a college or committee.

The Faculty Council has the authority to change any network-wide rule in the University, including the network-wide rules that minimally constrain all colleges, the network transaction fees, the budgetary procedures, and the rules that determine the Reserve emission rate (up to its maximum of $0.09\overline{9}\%$, or just below one tenth of one per cent).

The Faculty Council has the authority to direct The Woolf Trust in any way, including the disbursement of funds under its managerial control for any cause (this does not include the Reserve). The Trust retains discretion in the application of Council directives and cannot violate its bylaws. The Council is responsible for appointing the members of the Woolf Trust.

The Faculty Council has the authority to direct the Woolf Trust to initiate a change in the underlying blockchain network of the University. The Council may specify, within the constraints of the Trust's bylaws, that the Trust unlock the Woolf Reserve and allocate funds to a new mining operation. This is the only procedure and the only condition under which the Woolf Reserve can be unlocked.

Initiating a vote on any topic will require a quorum of proposers. The default quorum for initiating a vote in the Faculty Council will be 40%. When achieved, this will automatically trigger the poll. Default polls will close with an 81% vote in favour or against the proposal, or when 21 days have elapsed, whichever is sooner. The most recent closing date of a poll determines the most authoritative rule.

Woolf Development and later the Woolf Trust is tasked with providing an elegant and up-to-date user interface for voting, and linking this to the blockchain contracts which will eventually underlie all Council actions. Examples of online-petitions with user interfaces are common.[15]

The responsibilities of the Council are the responsibilities of Woolf Development until it can hand control over to the Council and Trust. This is planned for 18 months from the date of the token sale, but in no case will it be longer than 4 years.

7.2 The Monthly Budget Vote

Unlike the University Council, the monthly budgetary voting system pertains only to the proceeds of the Woolf Reserve. Every month 0.035% of the Woolf Reserve are automatically assigned to the successful items in the monthly University budget vote.

[15] https://petition.parliament.uk, Change.org, etc.

The holdings of the Woolf Reserve are described in 10.1 Token Allocation. Until Woolf Development has been able to implement the voting system and hand authority to the Woolf Trust, the monthly emission will be available to them, should they require it to advance the mission of the network.

Once a month, at the end of the month, faculty members must vote or be fined. Any time during the month that a proposal is entered into the system, faculty members can cast their vote for or against it, but votes can be changed until the last day the polls are open, and only the vote distribution at the end of the month, when voting closes, will determine the ranking of proposals.

Proposals meeting a threshold of 48% democratic support will be automatically allocated the funds directly by the blockchain. Proposals are funded in the order of their popularity until the 0.035% has been entirely used. Any unallocated funds will simply not be issued from the Woolf Reserve.

Unlike the University Council, there is no quorum for a budgetary item to be proposed for consideration. Voting is democratic and compulsory. Consequently, there is a burden on the system for every active vote. To prevent spamming the network with low quality requests, proposals cost the WOOLF equivalent of $400 to submit, and thus should first be discussed in the Woolf public forum to ensure that they stand a good chance of support. (This has been successfully practised with networks like Dash.) Successful proposals will have their promoters automatically reimbursed.

Unlike the University Council, the faculty members of a college may elect to assign their vote to a committee within the college. If a college policy states that its members must assign their vote, and some college members are dissatisfied with the internal polity of their college, and fail to secure democratic support for an alteration, they are always free to join another college with a polity of their preference, or to start their own college with a quorum of faculty members.

If the University faculty generally finds the monthly vote too onerous, they may use the University Council to change its default assignment to the colleges. For instance, they may propose that 1 college provides 1 weighted vote; and 1 college vote is algorithmically weighted by a college's total number of teaching hours, faculty members, and WOOLF holdings. This would prevent a dishonest college from being formed merely for the purpose of overthrowing the network (although in all cases, faculty members must have taught 8 tutorial hours to be eligible to vote).

Unlike the University Council, any faculty member or any entity that has staked more than 10,000 WOOLF tokens may offer one budgetary proposal per month. Any student of any college may request that its college or a faculty member put forward a proposal. It remains that only Faculty members can vote, even if they have made none of the proposals. Proposal submitters with a long record and evidence of success will be more likely to achieve attention and democratic support for expensive projects, particularly if the projects are assigned to a group other than the Woolf Trust or its known assignees.

Monthly token emissions will include the monthly budget for core projects on the network conducted by Woolf Development – and once authority has been handed over to the Woolf Trust, by the Trust and its assignees. The bulk of the proposals are anticipated to be suggestions from faculty members or those members of the public staking the requisite sum of WOOLF.

Budgetary proposals must show how they will support the improvement of Woolf University, and voting faculty members will, in the first instance, prioritise core development projects, and projects offering good value for money. However, monthly budgetary proposals are expected to include various items for college research, profile-raising study trips, and scholarships for new colleges to attract students. In general, it is expected that a record of successful proposals with evidence of good outcomes will precede requests for large monthly projects. Colleges may have their own internal processes for prioritising and putting forward proposals, and sensible college proposals are likely to garner popular support.

In passing we can note that the monthly budgetary voting system reduces the likelihood of WOOLF being classified as a security because (1) managerial efforts are diffused, (2) managerial efforts are subject to democratic oversight, and (3) tokens are not typically offered in exchange for money but are used as payments for work. Of course, our efforts are not designed to show that our tokens are not securities, but to promote the democratic, non-profit values which are to be coded into the network.

7.2.1 Sources of the University Budget

University expenses may include software development, legal representation, college on-boarding and document checks, student recruitment, and public relations. Once Woolf Development has handed authority over to the Woolf Trust (which is under the authority of the University Council), the University budget is funded by three possible means. All three means are subject to Council revision.

(1) The Woolf Trust will be charged with managing the endowment and maintaining a net surplus. Financial advisors will oversee the creation of an investment surplus from the endowment, pending legal approval for the activity. The surplus is applied to special projects under the direction of the University Council. A percentage of the proceeds of the surplus may be deposited in the Woolf Reserve.

(2) The Woolf Reserve will allocate up to a maximum of 0.035% of its holdings to the addresses of the budgetary items successful in the monthly vote, as described above in 7.2 The Monthly Budget Vote. The council may increase the maximum allocation but cannot exceed $0.09\overline{9}\%$.

(3) If 1-2 prove inadequate or are at a future date exhausted, the Council may vote to impose a minuscule transaction fee to be automatically deposited in the Woolf Reserve. Similarly, if the University faces difficult financial circumstances, the Council, made up of all teaching faculty members, may elect for colleges to give up to a maximum of 1% of their tutorial fees directly to the monthly budget.

7.3 University and College Awards

As a blockchain university, Woolf will be governed by rules that determine relationships across the entire network. University-wide rules delineate the criteria by which University degrees are awarded. These rules are to be embedded in smart contracts and thus execute automatically upon the blockchain when their criteria have been satisfied. Woolf degrees will be indelibly linked to the student's unique but anonymized record on the blockchain.

The legal recognition of Woolf University degrees will be the responsibility of the Woolf Trust to secure. Their legal standing will not prevent the network from continuing to issue its awards in accordance with the network rules. Such a process is entirely separate from any awards or degrees issued by the colleges of the University, some of which may already have legal status.

The University does not prevent its colleges from issuing their own degrees and certificates, whether on the blockchain or through traditional legal pathways. However, we hope that in future, Woolf University degrees and awards will carry the greatest recognition. We expect colleges to compete for University distinction on the model of the Norrington Table[16] or *The Times Higher Education* 'World University Rankings'. Metrics of college performance will be public and indelible.

Today there are no common standards for university grades or University degrees. There is not even a common global effort to achieve a single framework for student assessment. Scottish undergraduate degrees are called MAs and require 4 years of research, whereas English undergraduate degrees require 3 years and are called BAs, but an MA is automatically conferred after 5 years of completion at Oxford and Cambridge. In the United States, Harvard University uses a 4 point scale, whereas MIT uses a 5 point scale. Similar variety exists in most western countries. There is no common method of conversion between university marks or between university degrees.

By placing all of the colleges within a single system, it will be possible to apply key metrics across all college activities with accuracy and security. A Council vote will determine the criteria of Woolf University awards and degrees, and these will be applied to those who complete courses in the colleges, regardless of whether those colleges issue their own awards.

We expect a network-wide consensus of the University to increasingly represent a global academic consensus. Thus we foresee increasingly standardised conversions between existing marking scales, and we foresee Woolf University awards and distinctions becoming an international standard of excellence. Their issuance on a blockchain provides a standard of credibility that is lacking in many countries.

There is nothing to prevent existing, degree-granting universities from becoming 'colleges' on the network because Woolf does not bar any eligible college from being

[16] https://en.wikipedia.org/wiki/Norrington_Table

formed. Indeed, we expect many traditional universities and liberal arts colleges to adopt Woolf and phase out their administrative staffs, and the Woolf Trust will be prepared to help Universities adapt to the change.

The Woolf Trust will provide an advisory taskforce to help ensure a smooth transition for traditional institutions, so that existing social practices can be adapted to integrate with the network and thereby capture their value – ensuring, for example that 'check-in' procedures are followed so that students received course credit.

Integrating existing educational institutions with the Woolf network will automatically force smart contract compliance on all network activities, including the use of bidding pools. Network-wide rules will always constrain the decisions of the colleges, which will remain otherwise free to govern themselves as they see fit. Both college and University rules can be changed through democratic consensus. Major new institutions offer benefits to the Woolf community as a whole because all miniscule transaction fees contribute to the community's democratically controlled central fund, and may add value to the native token. Thus prospective institutions may be able to persuade the community to mitigate or revise some rules (7.2 The Monthly University Budget and 8.2 WOOLF Valuation).

7.4 The Class Runoff Process

Colleges can offer degree courses based on their teaching resources. Colleges cannot offer courses that are not tied by smart contracts to faculty members of the college, so only a college with mathematicians can offer courses in mathematics. Teachers contractually obligate themselves by their offers, which keeps teachers honest. Teachers must typically collaborate to offer complete degree courses, which means that only a conspiracy of the dishonest can offer a bogus degree.

To fulfil the requirements of their degree, students typically have fixed, general classes alongside many optional classes. Students often enjoy an increasing number of elective classes as their degree progresses and they have satisfied the college's fixed prerequisites. Elective classes tend to be of greater specificity, and their qualified teachers tend to be scarcer.

As the head of any university department knows, this creates a risk of default, since the delinquency of a single teacher could prevent a class from running. It also presents risks to teachers, since a class requiring advanced preparation may not be chosen by students. Above, we identified these risks as liquidity problems (2.1 Diagnosing the Problem). Woolf University provides solutions.

Whenever a college defaults on its obligation to teach a course, then the class runoff system is triggered and the tuition is put out to bid (7.5.1 The Tuition Bidding Pool). This is true whether the course is a scarce elective or a general introduction. Whenever a teacher has prepared a course which students do not select, she can put it out to bid.

The runoff solution will provide a simple user experience for all parties, however complex its underlying smart contracts. Students at any college indicate their first-,

second-, and third-choice for an elective class. Selection is made by an agreed upon date, e.g. before the start of each academic year. If a student selects elective 1, but the college cannot fulfil its offer, then the tuition is automatically put into the general bidding pool accessible by all other colleges. Any qualified faculty member at any other college can offer to teach the class, and the home college must credit the teaching towards the original degree.

If the student is not satisfied with the indicated price, quality, or timeslot of the alternatives in the bidding pool, she may refuse the offer and take her second choice at the home college. The process is repeated a second and third time, after which the college has the right to offer any elective that fulfils the stated criteria for credit towards the degree course, and the student has the right to transfer to another college.

This model of run-off choices prevents colleges from becoming silos that cannot adequately coordinate willing students with the supply of classes. It ensures that students will receive the tuition for which they have enrolled throughout the duration of their degree, and it ensures that a pathway will be found to degree completion. It gives everyone greater confidence, accountability, and clarity in the process.

The Tuition Bidding Pool allows any professor to offer tuition beyond their contracted college duties, and it gives any college time to adjust to the loss of a teaching member. Whenever a teacher prepares for a course which is not elected by the students of the college, it can be offered in the general bidding pool.

Only colleges can offer degree courses and colleges retain the first right to teach their own students, but to protect the Tuition Bidding Pool for the whole University, it will be stipulated that no college can forbid its faculty members from teaching in the Bidding Pool, and no college can forbid its students from studying in the Bidding Pool. Conversely, the blockchain will clearly demonstrate if a college becomes dishonest, simply brokering its students in the Bidding Pool; such a college could be automatically suspended. If a college fails to teach its students, this fact is not only public, but it can also be automatically used to change their ranking in the system.

The Class Runoff Process is a network level rule in the smart contracts governing the whole University, which ensures that bona fide courses are offered, that student choices are honoured, and that student-teacher coordination remains effective. Only a University consensus in the Council could change the rule or allow exceptions, which helps to ensure a well-coordinated network in which dishonest actors cannot flourish. Accepting the porous nature of college boundaries will be difficult for some traditional universities when they join Woolf, but it will be to the collective good of the students and the teachers.

7.5 The Bidding Pools

Coordinated bidding pools are engines of academic activity on the Woolf network. The most prominent is the first to be proposed for development, namely the general bidding pool for tutorial course instruction.

Two further bidding pools are likely to be developed, each with distinctive parameters that can only be changed by network consensus: The Administrative Bidding Pool and the Peer-Review Bidding pool. A student-to-student peer-review bidding pool would have to be considered for deliberation in order to form contractual conditions that disincentivize cheating.

7.5.1 The Tuition Bidding Pool

The tuition bidding pool will allow academics to teach what they are most effective at teaching, and it will allow students to study what they most interested in learning – regardless of geography or institutional affiliation. The bidding pool is a strategy for removing institutional, academic silos and letting students and teachers connect across the globe.

Visually, a bidding pool organises information like Airbnb organises properties, or an airline search engine organises flights: users offer restricting criteria and options are made available. In this case, the options are potential classes that a student might take with a particular tutor.

The tuition bidding pool is distinct from any college's course offerings. It consists of a coordinated, open exchange between courses and students, and it is accessible by any member of the University. Any faculty member can place classes into the bidding pool, although smart contracts will prevent conflicts with other commitments.

The bidding pool must be so organised that students can easily find the courses they want, and it must allow teachers who want to make an offer to be easily found by students. This is a problem of coordination and visual representation. Here we address only the former.

With maturing infrastructure, it may be desirable for students to select several course criteria and for faculty to receive automatic notice that they are eligible to provide the course. In that case, Faculty members need not place their course offerings into the bidding pool, but can merely respond to existing offers.

7.5.1.1 Coordination in the Tuition Bidding Pool

Classifying academic projects according to a common rubric is already standard across academia. This can be seen in major grant making bodies, like the European Research Council, which organises all research projects under two or three nested subject classifications. A single project might be (1) 'Humanities/Philosophy/Ethics' and (2) 'Humanities/Classics/Literature' and (3) 'Language/Greece/Plato'. This allows any project to be rapidly discovered. Call it the multiple nested hierarchy strategy.

A second strategy uses metadata tags without nesting. This allows courses to be listed across a set number of interests, for example: History of Ideas, Plato's Phaedo, Ethics, Afterlife, Attic Greek Grammar. Such a course might be eligible for a student looking to fill a requirement in any one of several degree courses (philosophy, Greek history, Religion, language, Liberal Arts, and so on). The balance of generality and specificity in the labelling is independent of whether they can be hierarchically nested. Call it the metadata labelling strategy.

Like the nested hierarchy strategy, the metadata labelling strategy has already been used successfully in classifying academic research. This can be seen in the crowd-sourced classification of academic projects on platforms like academia.edu. There, people label their academic papers for the interested public, and express interest in papers that fall under certain labels. If a label is too broad, the paper will fail to stand out from the crowd, but if the label is too narrow, the paper cannot attract wider attention. The offer-seeker relationship is balanced by market-like forces, and that makes it possible for those investigating cuneiform tablets or quantum theory to quickly find each other.

Many digital marketplaces, such as flight search engines or online classified advertisements (including Craigslist, Gumtree, and so on), allow buyers to search or browse with adjustable parameters (date, location, price, and so on). The restrictions of such parameters allow the buyer to review a range of options. We believe that the effort to coordinate teachers and students will be no more difficult than any of the existing options, even if it must blend features from several of them.

One minor point is notable with respect to coordination in the tuition bidding pool. It could be desirable for a college to assign its administrator to act like an agent, securing the best teaching for the college members from the bidding pool. This will require democratic review.

7.5.2 The Administrative Bidding Pool

It is not presently possible for all administrative tasks to be automated by smart contracts, and it is not desirable for all administrative tasks to be publically available, especially where personal information might be at stake. Dedicated administrators will be necessary, though we will aim for a ratio of 1 administrator per college with a further needed for each 1,000 students. Eligible tasks, which do not risk sensitive data, will be permitted to be put out to bid in the general Administrative Bidding Pool.

Here we do not intend to examine the processes of the Administrative Bidding Pool in detail, which are similar to the Tuition Bidding Pool. However, some distinctive features can be noted.

In addition to administrative individuals, the university may ultimately allow administrative companies, whether small or large, to join the bidding pool, bidding to perform tasks for academics, but the parameters of such a decision will be subject to democratic oversight.

A single administrative task, once placed in the bidding pool, might receive an offer by individuals or by an approved company. Individuals and companies will both require profiles, like hosts on Airbnb, and a record of success, like sellers on Amazon. Complex administrative tasks require more trust between the parties, and thus benefit from metrics of trust. Buyers are accustomed to trusting an Amazon seller or an Airbnb host whom they have never met when hundreds of others have confirmed that they are trustworthy.

For example, teachers organising a summer conference in Rome might seek a single venue with various parameters. The task might be put in the administrative bidding pool, and an administrator with relevant experience might offer to find the venue, negotiate a price, and book all of the participants. Smart contracts would protect all parties involved: successful administrators would build a record on the blockchain (like course credit). The administrator might offer three eligible venues to the teachers, and might be paid a further bonus when the hosts accept one of the venues.

7.5.3 The Peer-Review Bidding Pool

We believe the current methods of academic peer-review are ripe for improvement. Poorly compensated reviewers, protected by anonymity, sometimes lacking relevant expertise, are not well-disposed to providing the sort of thoughtful and critical feedback which is essential to academic progress. This is related to wider problems in the academic publishing industry (7.6 The Woolf University Press).[17] We believe Woolf University could solve both the problem of peer-review and the problem of publishing. Here we discuss the former.

The double blind, half-blind, and open peer-review processes are widespread in academia. They are used to determine career progression, allocate funding, improve research, and gain publication. Almost all of these processes could be improved and made fairer by a liquid bidding pool, adequate compensation, and clearer democratic oversight. The Woolf Trust will be instructed to prepare and open the Peer-Review Bidding Pool when the faculty of Woolf University reaches 500 members.

The Peer-Review Bidding Pool will function much like the Tuition Bidding Pool. Only faculty members can enter as reviewers in the bid pool, and only faculty members satisfying sufficient similarity of classification can review each other's work. So for example, a teacher whose blockchain (anonymously) records their having taught many Caesar Augustus classes, and having published on Caesar Augustus, will be eligible to review a paper about Caesar Augustus.

As with the Tuition Bidding Pool, requests for peer-review must balance generality and specificity in order to coordinate expertise. Democratic deliberation will be essential to developing smart contracts that ensure (1) enough specificity is achieved to produce serious insights on the topic, and (2) that too much specificity does not create an echo chamber which is immune to the criticisms of those working in adjacent sub-disciplines. This might require one matched specific reviewer and one reviewer in an adjacent discipline. The calibration of subject areas, the social distance of the reviewers (e.g. whether they have ever worked at the same college), and other factors can be coded into the process and managed at the level of the blockchain. Complex combinations of criteria governing the smart contracts should lead to the opposite of complex user-experiences – they should lead to elegant, natural, and clear processes.

The rules governing such a process may have to be adjusted, but adjustments can be made on the basis of more information and public deliberation than has perhaps ever

[17] https://www.theguardian.com/science/head-quarters/2015/mar/12/games-we-play-troubling-dark-side-academic-publishing-matson-sigafoos-lancioni

before been possible. Today, many peer-review participants report extreme oddities and uncertainties in the review process; these would be humorous if entire careers were not so often at stake. Today, the criteria by which reviewers are chosen are potentially open to manipulation allowing editors or faculties to fast-track or obstruct reviewees of their choice.

Editors, faculties, and funding bodies waste valuable time searching for reviewers and eliciting their reviews. Reviewees are told to wait months or years while their work is under review. The Peer-Review Bidding Pool of Woolf University will be designed to remove these uncertainties and clarify the career paths of university members.

Ultimately the fairness of criticisms raised in a review are matters of debate at the level of the review's content. Anecdotally, scholars tend to be more considered in their criticism when speaking in public, whereas they may sometimes be hasty and cruel when writing under the protection of anonymity. For such reasons, the democratic processes of Woolf University may limit the use of double blind peer-reviews to a minority of cases.

Blockchains make available new combinations of anonymity during the transfer of information. They can do this without a third party, like an editor or faculty committee. Here we outline two possibilities for improving the quality of peer-reviews without dispensing with anonymity.

Feedback. The first possibility entails the reviewee providing feedback on the quality of the reviewer's comments. The anonymity of a peer-reviewer is not at stake if the reviewee rates or flags the fairness of a reviewer's criticisms, and such ratings can accumulate to a reviewer's blockchain record without either party ever being disclosed to the other.

It remains essential that reviewers have the liberty to write honestly, and state critical objections clearly without fear of penalisation. Websites like ratemyprofessor.com may have incentivised leniency of teaching or triviality of feedback. To avoid incentivising lenient reviews, the blockchain can also keep a record of the reviewee's feedback on reviewers. If a scholar is widely reviewed as poor, but that scholar consistently reviews all feedback as unfair, then this would be evident. Thus it would be clear that an experienced reviewer is consistently rated with 5 stars for fairness, whereas the bad scholar consistently rates reviewers as only possessing 1 star for fairness.

Such complexities at the level of the blockchain need not translate into complexities of user-experience. What matters is that the criteria have been approved in a transparent and democratic process so that academics are presented with options in which they are incentivised to do the best thing the most spontaneously.

Partially-blind reviews. The second possibility is to recognise that social accountability and reductions of anonymity can stimulate more balanced and considered criticisms. A double blind review could be set by the smart contract to reveal all parties to each other upon submission of comments. Alternatively, a smart contract could make the

content of submitted reviews visible to all parties without revealing anyone's names; thus every reviewer would anticipate the views of other reviewers but remain anonymous. And it would be possible to make the reviewers' names visible to each other upon submission, even though the reviewee remained uninformed. Such partial exposures of the people reviewing may provide a sense of social accountability and stimulate more considered reviews.

Today, scholars have little control over review processes that can dramatically affect their own careers. For example, book manuscripts are given to publishers who ask, beg, or entreat scholars for reviews. Since the scholars are largely unpaid, publishers cannot be demanding; and since scholars are not paid (or paid only nominally), they cannot prioritise the review. Deadlines often stretch, and reviews can take months or years.

The smart contracts in the Peer-Review Bidding Pool will provide far greater assurances. As with tutorials, the fulfilment or violation of their stipulations can have immediate financial consequences. Missed deadlines may produce direct compensation for a reviewee, whereas the fear of missing a deadline is likely to produce offers with lower prices and longer timelines. Scholars who anticipate that a review will have a dramatic affect on their career or salary may well be willing to pay for a rapid and thorough review process, or may stipulate that only a partially-blind review is employed. We believe the Woolf model of peer-reviewing will become a global standard of credibility and fairness by putting the process back into the hands of the academics, and by making the governing rules transparent and democratically accountable.

7.6 The Woolf University Press

Here we discuss Woolf University Press as a publisher of peer-reviewed academic work, not as a printer of physical goods. This is a long-term rather than short-term goal, and one that will benefit from democratic deliberation within the Woolf network. Such work will fall to the Woolf Trust and is not the immediate responsibility of Woolf Development (5. Legal Entities).

We foresee the split between publishing and printing becoming wider. It is already the case that publishers send digital copies to printers all over the world, which are printed locally, on demand, when a person places an order – regardless of whether the order is placed with the publisher or through a marketplace like Amazon. Academic publishers like Cambridge University Press already outsource some of their printing needs, so that, for example, Amazon prints and sends the physical books to an American customer. In future, we expect publishing to be even more distinct from printing, and for physical printers to cater more closely to their local markets.

Academic publishers function largely as brokers between content submitters and content reviewers. Academic publishers typically offer negligible compensation for the submitted content, if any. These publishers then typically pay (at most) negligible amounts to peer-reviewers. Moreover, academic publishers decreasingly provide substantive editorial guidance to academics, like intellectual direction over the argument of a work. Over the last decade, academic publishers have increasingly

outsourced their editing to companies relying on automated software, or they ask the content providers themselves to undertake the task. The consequence is that academic publishers sometimes have impressive profit margins. Academic publications – full of 'free' content reviewed by underpaid reviewers – can then be sold at this startling profit back to the very Universities which produced the research.[18]

Many academic publishers are private, for-profit companies. The underlying research, and indeed sometimes the very text which academic publishers publish, is increasingly open access, and in many cases, it is open access by law.[19] In some cases, this means that publishers – who do not provide research funding, content, printing, editing, or the labour of peer-review – are organising the sale of 'free' goods to the public, which has sometimes already paid for those goods in their taxes. We believe that Woolf University will be well positioned to partner with those who seek to disrupt this business model.

We recognise that the branding of key academic presses provides a useful signal of editorial judgment that cuts across subject areas and shortens the search for the best text on a topic. We believe that such credible endorsements will not die out in the coming decade, although the number of prestige labels which can command such respect may decrease.

We believe that Woolf University Press could provide needed solutions to some of the current problems of academic publishing. Those problems can be summarised as (1) peer-review, (2) prestige branding, and (3) monetisation. Traditional publishers are decreasingly attractive partners on all three counts.

Peer-review. In the first instance, we believe that the peer-review process can be better handled in The Peer-Review Bidding Pool (7.5.3).

Prestige Branding. If Woolf University achieves its aims and become a global university, then the selective use of its imprimatur will have the power to garner widespread respect and recognition. The peer-review process will help to determine which works are worthy of the Woolf University Press.

However, we recognise that academic publications come in many linguistic and cultural varieties and no common metric for excellence unites them. This is in accordance with the democratic principles of Woolf University. It will thus be desirable to grant every college template its own publishing mechanisms, provided their work has gone through the Peer-Review Bidding pool.

An academic publisher offers its brand as a simple indicator of quality. We believe that a more complicated and refined set of criteria are being increasingly applied by academic readers to academic publications (and indeed by large university which

[18] https://www.theguardian.com/science/2017/jun/27/profitable-business-scientific-publishing-bad-for-science , 'Of Goats and Headaches' in The Economist, 26 May 2011.
[19] Cf. http://www.rcuk.ac.uk/research/openaccess/

operate in multiple countries). Woolf University Press would be well positioned to accommodate those tendencies and subject them to public deliberation.

We believe that readers of academic books are decreasingly likely to make their decisions on the basis of an academic publisher's advertising or imprimatur, but rather, that they will turn increasingly to social networks and online sources for their inspiration. Many readers already ignore the publisher and attend to other criteria, such as how many times a work has been digitally downloaded or recommended. Academics increasingly rely on an author's website, such as a faculty profile page, or they rely on a network like academia.edu, in order to discover and download open-source academic works. Academics increasingly rely on alternative signals for an academic work's credibility, salience, and importance – such as the reputation of the author or number of times it has been cited. We hope these processes will continue to put academic work more firmly in the hands of the academics themselves.

Monetisation. We believe that blockchains with smart contracts make it possible to fund research and monetise publications in novel ways. Blockchains could make it possible for every editorial change in a book or article to be instantly updated across the blockchain. Blockchains could make it possible for every reader to automatically pay for new editions if they accept the changes. Blockchains could make it possible for an author to be paid a tiny fee whenever a digital book is transferred from one reader to another. Blockchains could make it possible for an author to be paid directly whenever a book is transferred to a qualified physical printer.

The Woolf Trust will be tasked with the development of Woolf University Press once other university processes are running adequately to the satisfaction of the Council.

8. Revenue and WOOLF Valuation

Student tuition is the main revenue stream that adds fundamental value to the WOOLF token. Students seeking tuition purchase WOOLF, which provides the service of integrating their activities (both financial and educational) with a smart contract system, and thereby protects them with guaranteed outcomes stipulated in the contract. As a service, the smart contract system is designed to curtail administrative costs so that students can afford to study directly with professors. The student and the professor can connect without prior trust because of the smart contracts: if both parties check-in to the tutorial at the agreed time, then the contract will execute, giving the student credit and giving the teacher payment; but if one party fails to check-in to the tutorial, then the smart contract will execute with asymmetrical outcomes (4.4 'Check-In').

8.1 Tuition and Salary

Woolf University is disruptive and financially innovative. It aims to charge its students low tuition fees and to pay its faculty high salaries – and puts both parties in charge of their own success. Eventually, any group of qualified academics can participate in that innovation by starting their own college on the platform. Provided the academics meet the minimum criteria for starting a college, doing so is as simple as organising an academic conference. The Woolf platform will aim to provide a turnkey experience so

that the ease of starting a college is comparable to hosting a property on Airbnb. Any student should be able join the platform and receive a personal apprenticeship in thinking. Any student can study immediately in the general bidding pool, or apply to start a degree course at a college, and doing so should be no harder than booking a room on Airbnb.

Financial estimations in this white paper are products of our good faith, best analysis and are meant for illustrative purposes.

Woolf has a default University-wide rule that faculty members cannot charge less than $150 per tutorial. A democratic consensus could change that number, but it means that a college concentrating on high growth countries such as India, which currently sends talent overseas, could charge its students competitive annual tuition fees ($7,200), while a faculty member who taught only 6 tutorial hours a week would earn $18,000, an attractive salary for academics in a country such as India.

Consider Ambrose. In order to protect its high teaching standards and the good salary of its teachers, the College codes into its smart contracts that all faculty members may not charge other than $400 per tutorial. This figure may only be changed by a democratic consensus in the College, although Ambrose can always offer scholarships to its students without reducing teacher salaries.

Here are three potential tutorial rates and their affect on annual student tuition:

Charge per tutorial	Annual Tuition		
350	16800		
400	19200		
450	21600		

From an international student's perspective, Ambrose is competitive without scholarships. A student at Ambrose has a full workload when preparing for two tutorials per week, since the student must write an essay for each tutorial and be ready to discuss its claims for an hour. A typical degree at Ambrose consists of 2 tutorials a week, 8 weeks a term, 3 terms a year. That is 48 tutorials per year, or $19,200 per year before scholarships. This makes it comparable in price to many American state university tuitions, and makes it highly competitive in the global market.

At a major public university, however, one would expect to join a classroom with dozens or hundreds of other students, and potentially hear material that is already freely podcasted over the internet. At Ambrose, students are personally trained by world-class scholars. That makes Ambrose comparable in style to America's top ranked liberal arts institution, Williams College, where tuition is more than $50,000.

From a teacher's perspective, a mere 6 tutorials per week at Ambrose would mean $57,600 per year, assuming the teacher conducts tutorials with only one student per session and teaches only 3 terms per year, or 24 weeks. A teacher might provide 4, 6,

or 8 tutorial hours per week. Here are 3 potential workloads for a teacher who has *one student* in each tutorial and their affect on annual salary:

Charge per tutorial	4	6	8
350	33600	50400	67200
400	38400	57600	76800
450	43200	64800	86400

Many experienced tutors find that having 2 students in a slightly longer tutorial creates valuable interactions and insights for all parties. Whether this will be an allowable or common practice must be determined at a collegiate and university level.

Logistically, teaching two students is no problem when the members are all physically present in the same room, but it would require technical care if it were to be managed over a platform like Skype or Google Hangouts. Ambrose may find it worthwhile, if testing tutorials with two students over the internet, to buy its students extra computer monitors and pay to have them installed. The financial consequences are obvious, since a tutorial with 2 students might lower student fees while dramatically increasing teacher salary.

To address financial competition in the British environment, Ambrose may elect to teach all local, on-site tutorials with 2 students at a time, and to lower 'home fees' to $250; this would reduce the annual tuition below the typical annual fees charged by major British universities, which are £9,250 per year, or $270 per tutorial. Provided that student fees remain above the university requirement of $150 per tutorial, colleges are always free to respond to local needs in order to remain in-line with best practices and attract talented students. Colleges are always encouraged to develop their own scholarship programmes and develop a robust plan of outreach.

A teacher might provide 4, 6, or 8 tutorial hours per week. Here we show three potential workloads for a teacher who has *two students* in each tutorial:

Charge per tutorial	4	6	8
250	48000	72000	96000
350	67200	100800	134400
400	76800	115200	153600
450	86400	129600	172800

If the University network matures, local students will be more readily available to local tutors, no matter where they are in the world. Consider, for instance, how far it is to the nearest Airbnb rental, now that the Airbnb network has matured. We would expect similar levels of network saturation to provide new opportunities – not only local tutors but also opportunities for local student clubs. And as the Airbnb and Instagram generation enters University, travelling with a cohort to a tutorial location

for an 8 week term may be more natural, just as it is entirely natural for that generation to have important discussions with friends over Skype.

Ambrose, by democratic consensus, will automatically take 4% from the tutorial payments of its faculty members before taxes. Many members of Ambrose will elect to teach more than 6 tutorials per week, and many members will elect to teach beyond the three terms of the academic year, since these cover a mere 24 of 52 weeks. Others will be satisfied to pursue their own research interests, potentially on University funded projects.

With the college quorum of 30 faculty members teaching a mere 6 tutorials per week, a mere 24 weeks a year, the college receives revenues $92,160. This covers administration and a potentially a modest contribution to the college endowment. The funds are automatically deducted in the tutorial smart contract, using equivalent values of WOOLF, even if the student has paid in the fiat currency of choice, and the teacher will receive a fiat currency of choice (4. The Woolf Utility Token). If colleges become wealthier by building their endowment, they may be incentivised to engage in interesting real estate acquisitions.

A sympathetic professor, or a professor who cannot find any students for his elective in the history of basket weaving, might be keen to offer the tutorial at a lower fee. However, the smart contract prevents him or her from doing so, and only a democratic consensus in the College could change the college rule. If he or she tried to hold the tutorial outside the agreements of the platform, then the student could not receive credit on the blockchain for taking the course. Only on-chain agreements between the teacher and student will produce the course credit, and the on-chain payments are automatically transacted in conjunction with the tutorial agreements. This shows both the beauty of smart contracts and the importance of situating them in a democratic environment.

8.2 WOOLF Valuation

The value of the WOOLF token depends upon fundamentals beyond any speculative trading in the secondary market. Here we will consider just one of those: the value of money held in WOOLF smart contracts. These considerations do not constitute a promise of future value or investment advice.

The most prominent addition to the value of the WOOLF token would consist of the funds held in smart contracts.

If 1 college with 100 academics teaches 2/3 of their tutorials one-to-one, and 1/3 of the tutorials one-to-two, and if the academics teach only 6 hours per week, three terms a year, then the college is teaching 800 tutorials per week, 8 weeks a term, 3 terms a year. A student with a full workload requires 2 tutorials per week, and thus the college can teach 400 students. The students pay the equivalent of $400 per tutorial, or $19,200 per year.

On day one, the college has the equivalent of $7.68m locked in WOOLF smart contracts and thus the total value of WOOLF is $7.68m, excluding other factors. If 50

such colleges join Woolf, then the value of WOOLF will be $384m on day one of the academic year, excluding other factors.

Three notable factors then decrease the value of WOOLF with respect to funds held in smart contracts:

First, the above calculations consider only the first day that contracts come into force. Yet WOOLF loses funds as it pays out salaries to its teachers, who may be converting to fiat, since every tutorial triggers the smart contract for one tutorial payment. By the end of the academic year, the smart contracts would have been fulfilled, and the value of WOOLF would be 0, having discharged 100% of the smart contract terms (baring other factors, like funds held by the college from its 4% administration fee).

Second, the above calculations have students paying for a full year in advance, but some colleges will only charge one term or semester in advance. This would cut their capitalisation of the smart contracts by either 2/3 or by 1/2.

Third, the above calculation assumes that colleges will bill $19,200 in tuition, and although we foresee (but do not promise) many colleges charging much more, many could also charge less (subject to the consensus minimum, which is by default $7,200).

Nevertheless, as the network grows we expect smart contract capitalisation for tutorials to become more steady for two reasons: (1) a variety of overlapping academic calendars and course plans would integrate with the platform, and (2) the fluctuations in the value of WOOLF against fiat currencies could itself become a factor in the timing of WOOLF purchases and indeed the timing of the course offerings themselves.

It remains that the above considerations do not consider a range of factors that would capitalise WOOLF smart contracts outside the academic terms, including the possibility that students (1) take summer courses, (2) study in the general tuition bidding pool, and (3) use the language exchange school.

8.3 Target Market

How many users can Woolf University acquire? Above we described 50 colleges comprising 5,000 faculty and 20,000 students. That would make it very roughly the size of a geographically bounded university like the University of Cambridge. In fact, our target market is far larger. (Our market analysis does not constitute a promise of market success.)

Our total available market consists of the roughly 50% or more of professional academics who fail to find the employment that they seek. We are not aware of any solution that has been developed or proposed, anywhere in the world, that is comparable to our novel solution, which is the first blockchain-powered university. We believe that the democratic principles and revolutionary employment practices of Woolf position it to make significant and positive impact on the market.

Our most immediate target market will be more select and consist of the most digitally engaged academics. To get an idea of how many users Woolf University aims to attract

among digitally engaged academics, consider how many members there are of Academia.edu. The company claims, 'Over 59 million academics have signed up to Academia.edu, adding 20 million papers. Academia.edu attracts over 36 million unique visitors a month.'[20] Similarly, Researchgate.net claims more than 14m users.[21]

Those are impressive figures given that the users stand to gain neither a direct salary nor course credit for their involvement. If Woolf achieved 2% of Academia.edu's membership as paid academics with only one student each, there would be 1.18m students. If their smart contracts only ever held 5% of the $19,200 annual tuition, the capitalisation of the smart contracts would be over $1.13bn. If their smart contracts only ever held 25% of our $19,200 annual tuition, the capitalisation of the smart contracts would be $5.66bn.

If Woolf achieved 2% of Researchgate.net's users, there would be 280,000 users. If each user had a single smart contract, and their smart contracts only ever held 10% of our $19,200 annual tuition, the capitalisation of the smart contracts would be over $537m.

Of course, here, we have only considered short-term smart contract capitalisation for tuition, and we have ignored other contributions to the value of WOOLF, including the long-term holdings of colleges and academics, and other factors affecting the stature of WOOLF, including the secondary market. Such factors may contribute or detract from the value of WOOLF.

It is our hope that doctoral students and early career academics, facing a bleak academic job market and the potential of decades of career stagnation, will come to view Woolf as the default employment strategy for which they will actively begin preparing.

9. Incentives for Early Network Adopters

The first five colleges of Woolf University are to be endowed by The Woolf Trust, using proceeds from the token sale and allocated WOOLF tokens. The Woolf Trust exists to benefit the entire University, including all of its future colleges, not merely the first five colleges; but ensuring their success will help lead the way for the entire network grow and set a high standard of teaching and academic respect. By beginning with world-class academics with an Oxford background, we hope to attract a strong cohort of students.

Depending on the proceeds of the token sale and adequate market conditions, each endowed college will receive funds up to but not exceeding the equivalent of $5m, to offset start-up costs as the network matures. The colleges will also be provided with WOOLF token scholarships used to attract students. The Woolf Trust will prepare its infrastructure for all eventualities of WOOLF market capitalisation and valuation. The

[20] https://www.academia.edu/about
[21] https://www.researchgate.net/about

value of WOOLF may be affected by trading on the secondary market, and the generosity of the Trust will depend upon financial conditions.

It is our desire for Woolf University to reach the most able students no matter what their financial circumstances or where they are in the world. The first students who are admitted to the first five colleges will be eligible for scholarships. The number and value of the scholarships will depend on the proceeds of the token sale and market conditions. Payment for every scholarship-dependent tuition hour will be provided by The Woolf Trust, included in the student's smart contract, and paid to the teacher at the time of the tutorial 'check-in'. This provides an especially exciting access opportunity for bright students across the world who might not otherwise be able to afford the tuition or travel.

These funds will allow the Colleges to attract students and build trust in the University. The funds will also allow the colleges to attract quality faculty members with earmarked payments. And it always remains the case that if a student fails to check-in to a tutorial, faculty members can have the confidence that they will be paid if they fulfil their own check-in obligations.

10. Token Allocation and Token Sale

Woolf has sought a sound approach to the issuance of its utility tokens; we have incorporated in Gibraltar because it provides a credible, regulated environment in which to operate. Woolf Development always seeks to act within the laws of Gibraltar, for which the Judicial Committee of the Privy Council in London is the final court of appeal. Users of our utility tokens must agree that we are not offering securities and we make no promise with respect to their future functions. We hope this better protects all parties and increases the long-term durability of the Woolf network, but we can offer no guarantees.

The job of Woolf Development is to launch the WOOLF utility token. It will also aim to guide the network until, minimally, it (1) achieves a basic version of the check-in procedure (4.4 'Check-In'), (2) offers a democratic governance mechanism for allocating WOOLF to development projects, and (3) counts excellent academics as registered members.

Information about the token sale economics can also be seen in a separate document. There is no minimum threshold or soft cap and the hard cap is defined as 20% of the total supply. The committed team of core leaders aims to bootstrap the network in the event that the token sale falls dramatically short of expectations.

Pricing per token is on a sliding scale from $0.75 to $0.99. This assumes (but does not suggest or promise) a sliding scale of market capitalisation from $38m to $50.5m given the first year's estimated token supply (including emissions from the Woolf Reserve). Woolf Development makes no promises about the future price of the utility token.

10.1 Token Allocation

The WOOLF token is a pre-mined ERC20 token, which means that the total supply of tokens will not change. However, the Woolf Reserve locks a portion of the tokens away and stipulates that only 0.035% of the Reserve tokens can be released from the Reserve per month, and only if they are matched to projects that improve the value of the network, as identified and allocated in the monthly budgetary vote (7.2 The Monthly Budget Vote). This is meant to peg token inflation to value-delivery for the network. The length of meaningful token emission from the reserve is estimated at over 300 years. Tokens allocated to Woolf Development and the Woolf Trust are subject to vesting.

Thus, at the outset, the total circulation of tokens is a fraction of the total number of possibly circulating tokens. 250m tokens are minted, but 125m are locked in the Woolf Reserve and 75m put in the Woolf Trust and Woolf Development (subject to long vesting periods). The details can be seen below. This leaves 50m WOOLF tokens (or 20%) for the token sale.

The forecast of token circulation be seen in a separate document – the rate at which tokens enter circulation is conservative. The monthly emission rate from the Woolf Reserve is 0.035%, assuming that a full set of budgetary proposals receive democratic support, but it will be less budget proposals fail to meet the minimum consensus threshold. Since the emission rate is a fraction of the tokens in the reserve, the number of emitted tokens will be slightly less every month, assuming contributions are not made to the Reserve. Contributions to the Reserve are functionally deflationary and are possible in some circumstances (7.2.1 Sources of the University Budget).

The full allocation of tokens at the time of the sale will be as follows:

50% of the tokens are locked in the Woolf Reserve and released at 0.035% to the monthly budget

20% of the tokens are sold in the Token Sale, if the hard cap is achieved

18% is issued to Woolf Development for current and future employees (vested)

12% of the tokens are allocated to the Woolf Trust (vested)
- 6% for development projects
- 6% for college endowments

10.2 Proceeds from the Token Sale

Up to 20% of the tokens are sold in the token sale. Here we describe how the proceeds will be designated for the development of Woolf University.

Funds received from the token sale are dedicated to three main groups: core leadership activities, academics, and the network's institutions. The complete team can be seen on the project website, woolf.university. Budgets are in some cases capped with excesses deposited in The Woolf Trust or subject to voting procedures. The

breakout is as follows, with dollar allocations here assuming $40m in proceeds from the token sale:

Core Leadership. The core leadership team includes the founder and Director (Dr Joshua Broggi), the Technology Director (Mr Johann Lilly), and the Programme Director (Mr Martin Gallagher). They oversee further contracted and subcontracted legal council, accountants, software engineers, designers, and media specialists. They are also responsible for hiring UI/UX software developers, blockchain engineers, and consultants after the token sale.

35% – Core Leadership Team and their employees ($14m)

Academics. Academics consist of top-flight academics retained in the lead-up to the operations of Ambrose (6.3.2 Ambrose). They will be paid salaries in token sale-derived fiat currency not longer than 4 years. The initial number of academics is set at 30 but is subject to token sale proceeds and may be increased to prepare 10 academics for supporting the second college. The responsibilities of the academics during their 4-year tenure includes the following: (1) designing the course structure for the first college, (2) maintaining their world-leading reputations through research, (3) liaising with the software development team, (4) appearing in a promotional video for the media team, (5) creating lecture videos or podcasts for future students and placing these in the public domain.

Fiat currency funding for the retained academics outlasts the expected launch of Ambrose and secures their livelihoods as the pipeline of students increases with the network's maturity. It is assumed that the Academics will increasingly choose to take their salaries in WOOLF after the second year, especially if the network has met key milestones in maturation. Thus there is envisaged a period in which the earliest academics are paid both a salary in fiat and WOOLF earned through tuition. This is the price of retaining world-class scholars in a new institution.

25% – Retained Academics ($10m, capped at $12.5m with 40 academics for 4 years)

Institutions. The network's institutions require endowment, and together with its members, they require legal council. A media campaign will begin before the first college opens and seek to bolster the reputation of these institutions.

40% – Institutions ($15m)

12.5% – The Woolf Trust ($5m)
12.5% – Endowment of the first colleges ($5m)
7.5% – Media ($3m)
7.5% – Legal ($2m)

Not all of these budgets need to be exhausted, and they may be adjusted by Woolf Development with legal council and in consultation with our academic advisors. These projects can also be funded by democratic consensus (7.2 The Monthly Budget Vote).

11. Timeline

Many digital processes important to Woolf already exist in open-source or free formats. As the Woolf network scales, more of these processes will be integrated with the platform, and more of the platform will be automated with the blockchain.

The essential tasks for the core leadership of Woolf Development are (1) a network which can facilitate a basic version of the check-in procedure, (2) a network with the potential for further development because of democratic governance mechanisms for allocating WOOLF to development projects, and (3) a network which counts excellent academics as registered members. Woolf Development will aim to produce these features with a user interface of comparable ease to that of Airbnb, and Woolf Development will aim to facilitate the launch of Ambrose and its successful engagement with students. We will always endeavour to deliver above expectations and ahead of schedule.

During its tenure, Woolf Development will strive to implement all of the features outlined in this white paper, but those which are not completed will be passed on to The Woolf Trust. The task of The Woolf Trust is to implement and continue to develop all of the features outlined in this paper, including all of the bidding pools and publishing mechanisms, and to integrate those features with a Woolf University blockchain. This is a long-term goal, with a long-term funding strategy, and a long-term governance strategy. These long-term ambitions are not under the managerial control of those who launch the network with its utility token, although they may strive to contribute to those aims.

At the start, key processes of social coordination can be achieved by traditional means of agreement (board meetings, email, Google calendar, Skype, WhatsApp, and so on), and all user interfaces can be provided by traditional means – such as html websites, physical classrooms, and regular committee meetings.

The roadmap of technological adoption may be revised by democratic consensus. However, it is useful to outline a scalable process in which the essential services are prioritised and future projects are identified for action.

2018 Q1

1. Legal council retained.
2. Woolf has core positions filled.
3. The white paper has many rounds of review.
4. The Woolf website is launched and the white paper published.
5. Token pre-sale

2018 Q2

1. Main public token sale
2. Beta app launched on the network.
3. Software and blockchain development team is expanded.
4. Academic contracts are issued.
5. Legal team identifies jurisdictions of degree accreditation, starting with the fastest but including Switzerland, England, and the United States.
6. A media team is contracted.

2018 Q3

1. Non-degree seeking students use beta network on site.
2. The range of smart contracts is expanded.
3. The development team continues to improve website and user experience.
4. APIs in development for Skype, Google Calendar, and location services.
5. The academics offer draft course structure and liaise with software development.
6. The first college, Ambrose, is launched.

2018 Q4

1. On-boarding team is formed to help new colleges.
2. Non-degree seeking students use network across national boundaries.
3. A document verification service is hired.
4. A tutorial skills video is provided for both teachers and students.
5. Colleagues at Cambridge invited to form second college.

2019 Q1

1. Degrees become legally recognised in at least one jurisdiction.
2. Degree recognition under review in a first-choice jurisdiction.
3. Academics produce tutorial lecture videos.
4. Monthly budgetary voting given new user interface.
5. The Tuition Bidding Pool is integrated with the Blockchain.
6. University Council voting is integrated with the blockchain.

2019 Q2

1. First five colleges reach their quorum.
2. College formation is open beyond the *Times Higher Education* top 200.
3. A media campaign is launched to seek full network saturation.
4. Document verification team increased.
5. Administrative and Peer-Review Bidding Pools are opened.

2019 Q3

1. The Language Exchange School is opened with media campaign.
2. The development team continues to improve website and user experience.
3. On-boarding team increased to help brick-and-mortar institutions adapt.
4. The first pre-existing college integrates with the network.
5. Woolf Development reviews network maturity and consults with academics on handing over authority to the Council and Trust.

2019 Q4

1. The Woolf Trust led by a significant figurehead and experienced board.
2. Access is to student application systems pursued (UCAS, Common App, JUPAS, etc.).
3. Real estate under review for college sites and pop-up seminars.
4. Student services continue improvement.

2020 Q1

1. First five colleges have a complete pipeline of students in smart contracts.
2. Expanded student society support and real estate.
3. The Woolf University Degree criteria are put to a Council vote.
4. Native mining operation under consideration.

2020 Q2

1. The Woolf University Press is planned for opening.
2. The Woolf Trust identifies a major research initiative to fund with media coverage.
3. Woolf Development consults with academics on passing authority to the Woolf Trust and becoming an assignee of the Trust.