

Woolf

Building the first blockchain university



WHITE PAPER

August 2018

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Woolf

Building the first Blockchain University

4 July 2018

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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 an accredited, borderless, educational society which reimagines how teachers and students connect. It will rely on blockchains and smart contracts to protect relationships between students and educators, enforce regulatory compliance, and ultimately manage custodianship of tuition. It will be a decentralised, non-profit, democratic community in which the use of blockchain technology will provide the contractual stability needed to pursue a full course of study.

It is our view that the model set out in this white paper will alter the economics of higher education and provide new opportunities for both students and academics to connect across borders in a well-regulated environment. Blockchains with smart contracts can eliminate or automate administrative processes and reduce overhead costs; as a consequence, we believe that students will be able to 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. The aim of Woolf is to make that transformative experience available to everyone. 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 digital in its organisation, but teaching can be conducted either in person or over video calls. In either case, participants must engage with the Woolf app, which

connects to the Woolf platform and triggers the relevant smart contracts on the blockchain. Woolf will thus use digital technologies to reimagine how traditional forms of education can be sustained in a geographically agnostic manner.

Woolf's smart contracts are meant to reduce the need for a traditional university's administrative staff. Indeed, we hope many brick-and-mortar educational institutions will adopt Woolf and increasingly phase out key portions of their administrative staff, even while gaining access to new teachers and students.

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 is intended to be simple and powerful: students and teachers are brought together, no matter where they are in the world. The more students and teachers joining the network, the greater the range of options for everyone.

Woolf offers new employment practices. Woolf will be open admissions for qualified academics and selective admissions for students. Colleges of experts will be allowed form without regard to borders. The platform will aim to provide a turnkey experience for academic professionals forming new colleges and offering courses. Academics with a research doctorate will be encouraged to form new colleges on the platform provided that they meet the minimum criteria, and the teaching provision of these colleges will be accredited through Woolf University.

Woolf is currently in the process of working with regulators on degree-granting powers. Woolf's platform is designed to give its students custodianship of their own degrees with public confidence about their credentials – secured by the blockchain. In addition to working in dialogue with regulators in Europe, Woolf will seek to promote international standards in degree credentials on the basis of its own democratic exercises across all the colleges.

We prize democratic values and feedback on our design. Woolf Development Ltd is responsible for launching and developing the network, after which its governance will be passed over to the academic members and the non-profit Woolf Trust. It is thus essential that members of the Woolf community continue to provide constructive insights into the overall operations and design.

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1. Overview

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

Students face mounting costs and geographical barriers that prevent many bright students from getting access to the best education. Academics face increasingly insecure employment, preventing many from leading a fulfilling career. Woolf is designed to reconnect students and teachers across borders in an accredited environment.

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 key administrative tasks, lower costs, provide regulators with confidence, and allow the core educational experience to prevail, namely one-to-one teaching between academics and their students.

Woolf will use a 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).

The collegiate system allows Woolf to grow internationally by allowing colleges to distinguish themselves by language, reputation, size, and course offering. Only students admitted by a college are admitted to study for a degree. Colleges at Woolf

will be ranked in a central system. Admissions are expected to be more difficult for the highest ranked colleges

The first college at Woolf, Ambrose, is being organised by leading academics, mostly with a background from Oxford. 80% of the faculty in the first five colleges must be from the top 200 universities (using the Times Higher Education World University Rankings). After five colleges have been created, Woolf will become open admissions for qualified faculty members and selective admissions for students.

Our aim is for the formation of new colleges to be as simple as organising an academic conference, so that a group of professors can start a new college and obtain gainful employment doing what they do best. Woolf will provide professors with transparent employment opportunities in a blockchain-regulated environment, with contractually secure work of their choosing.

Essential administrative tasks 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 interact with the network's native token, WOOLF, which denominates the tuition. Using a token allows us to enforce the logic of the smart contracts in the platform's unit of exchange. Our aim is to create a university in which the bulk of administrative tasks are either eliminated or progressively automated by smart contracts.

One of the areas of savings we have identified is the middle layer of bureaucracy between the classroom and the regulator. The Woolf platform is designed to diminish this bureaucratic supply chain of information. The platform will provide a profile of the data relevant to an institution's accreditation and compliancy status – in real time, at almost any level of granularity. By using a blockchain, Woolf will be able to manage sensitive personal and financial information even while offering students and teachers uncompromised discretion over their personal data, in compliance with the European Union's Data Protection Rights.

The Woolf platform is designed to provide students, teachers, and regulators with clarity and confidence about the compliancy status of teaching within Woolf. This is essential for a borderless university. We have been working closely with European regulators to ensure that teaching will be accredited at Woolf without regard to geography, language, or national affiliation. This is an on-going process, which contains challenges, but we have benefited from serious and forward-thinking regulatory partners as we design our smart contracts to be in harmony with regulation.

Students benefit from studying in a well-regulated institution with efficient resource management. It is our estimation that a distributed ledger with smart contracts can support changes in the way higher education is managed, organised, and experienced. A blockchain enables the reduction, elimination, and automation of key bureaucratic processes, which potentially creates significant financial savings. At Woolf we use these savings to support a personalised teaching experience, directly with academics.

Woolf is not like other digital universities, and Woolf is not a system for massive open online courses (MOOCs). Unlike most digital universities and physical universities, the Woolf education will emphasise one-to-one personal tutorials. These are used both in the natural sciences and in the humanities.

Tutorial teaching consists of small classes of one to three students studying directly with a professor. Preparing for a single tutorial takes 2-3 days. A student must review about 150 pages of material (depending on the subject) and prepare a piece of written work – whether a mathematical problem or an essay. The student must then be ready to discuss their written work directly with a professor for about 75 minutes. At the end of the tutorial, the professor tailors the next assignment to the student's weaknesses and interests. At Woolf, like at Oxford, doing this twice per week is a full workload.

The academic year consists of 3 terms of 11 weeks, which includes cumulative examination. 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).

Courses offered by Woolf are designed to be conducted either online or in person. Students and faculty must use the Woolf platform (or app) to capture teaching data, such as starting a tutorial or submitting an essay, and this process is designed to work identically whether the teaching is online or in person.

Elemental procedures, like agreeing to the start of a tutorial (and the related activities of providing a grade, submission of an essay, providing course feedback, and other quality assurance mechanisms) will be quickly performed on a Woolf platform – whether the tutorial is conducted in-person or over a video chat platform (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.

Key terms of a smart contract cannot be circumvented because they are coded into the blockchain. This protects both parties and will allow Woolf to use smart contracts to enforce regulatory compliance for accreditation. 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 supports an environment in which students can better receive personal attention; and it ensures that each party is protected by the terms of the contract. Eventually, key 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 (7.4.2 The Administrative Bidding Pool).

The aim of Woolf is to facilitate the free flow of education around the globe, by directly connecting students and teachers across borders in a regulated, accredited university. In principle, we believe that a blockchain makes it possible for the ratios between administrators and academics to be significantly improved – in a non-profit, decentralised educational society where students can afford to study in small tutorials with the world’s experts.

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 university level can change the framework that relates all colleges in the federal university, including the common framework dictating internal college affairs.

The collegiate system is meant to support variety, without demanding uniformity across a subject area or across the whole network; colleges may differ in language, price, quality, geographical preference, and in the degree courses 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 would make it 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.

Woolf is designed to change higher education by offering students a personal education. The existing model, in which hundreds of students sit in a classroom, is less competitive than it once was: these same courses, and often better ones, are available online for no cost.¹ The existing model, in which students memorise information, is no longer as strategic: computers are simply better at information storage, and students need the tools of judgment to navigate ever-larger volumes of information. The existing model, in which students have limited access to their professors, is no longer desirable: Woolf aims to provide all students with a personal education.

Woolf has a clearly delineated addressable need. Today, most academics must *ask for permission* to practise their profession, regularly applying to their own 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

¹ For example, the Massive Open Online Courses offered free of charge by EdX.org, initially created by MIT and Harvard but now containing courses from many top universities. Similarly, many universities offer free podcasts of lectures and seminars, such as the University of Oxford (<https://podcasts.ox.ac.uk>). YouTube.com remains a source of many complete lecture sets.

faculties, and who conduct proportionally most of the university's teaching, 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, or even more often. 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, academics will have their qualifications checked and in order to become authorised to teach on the global platform without further permission-seeking. Verified faculty may start their own colleges or request to join an existing college. 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.

2.1 Diagnosing the Problem

The incentive problem. The current university system too often contains of badly aligned incentives with damaging outcomes. University administrations are often incentivised to increase numerically measurable activities as an assurance of quality; this may contribute to higher tuition fees, growing administrative staffs, unnecessary building projects, and lower pay for most academics. University students are too often incentivised to adopt ever-larger debts, to produce formulaic and safe answers, even while gaining diminishing access to their professors. Professors are too often 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 help to realign the incentives of all stakeholders. Woolf seeks to build a university incentive structure in which 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. Our aim is for students and academics to 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 Exchange Spread Problem. In the current university system, universities are like trading exchanges in which administrations benefit from large bid-offer spreads between student tuition and teacher pay. As a consequence, students (or tax payers) pay 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 reducing intermediaries, thereby narrowing spreads between 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 help to 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 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 (7.4.1 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 Germany⁴ work on insecure, fixed-term employment contracts or part-time contracts or 'adjunct'

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:

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 typically offer a fraction of the pay compared to the same work conducted on a secure contract. Academics on insecure 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 regularly 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 be designed to 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 Economics 101, but at the same time, fewer academics will possess this specialised expertise (7.4.1 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. It has been regularly noted that this would be advantageous any academic with responsibilities of caring for children or family members. 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 appear unlikely to progress into secure employment like the previous generation did. 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

<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 Chakraborty 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'.

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 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, sometimes see it done better on YouTube.

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 designed courses, meant 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 (MOOCs), podcasts, online encyclopaedias, and YouTube videos. Online data flows continue to increase in volume and global reach.

However, 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.

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

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>

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. 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. We believe will replace a badly coordinated marketplace with hidden criteria, unhelpful incentives, and damaging personal effects, with a more 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-based 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 will make possible one of the oldest ways that human beings really learn, which is through individual teaching and instruction. Such instruction cannot be provided by a bureaucratic system or a podcast or a MOOC or a book – although these are all potentially important.

Woolf will use 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 aims to be 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 make available unprecedented forms of organisation, in which 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

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.

currently act to raise tuition fees for students and lower salaries for teachers. Woolf aims to make 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, confidence in accreditation, 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.

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 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, using the Woolf app to engage with 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 a key 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 as pushing a button on the Woolf app, which will automatically accords the relevant credit to the student and the salary to the teacher. It is the most basic interaction in the Woolf network, and can be conducted without respect to geography (4.4 'Check-In').

Woolf is not a competitor with most online universities because it is not an online university; it is simply geographically agnostic and medium agnostic. It is not a competitor because Woolf University will be 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 and provide accredited teaching at the highest standard.

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. The personal tutorial system is a form of intellectual apprenticeship that cannot be conducted by robots.

When complete, Woolf will be a university in its own right, with full degree-granting powers up to the doctoral level. Members of Woolf leadership have been in close discussion with regulators in Europe. Woolf will provide a highly personalised education, emphasising direct tutorial supervision between teachers and students.

At Woolf, we champion outreach across borders, and MOOCs have been successful in reaching a wide audience. However, most students who begin a MOOC fail to complete it, and a lack of personal contact has been identified as one of the central reasons for this attrition. Most MOOCs consist largely of pre-recorded videos,

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

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 (7.4.1 The Tuition Bidding Pool, and 6.3.3 College Admissions).

whereas teaching at Woolf consists of direct, personal engagement between a professor and student.

There is nothing to prevent a teacher at Woolf from assigning a recorded lecture, but this is complementary rather than central to the teaching at Woolf. Certain factual material may be ideally delivered in lectures, whether live or pre-recorded, but critical thinking skills are formed in one-to-one feedback. Teaching at Woolf is designed to address an individual's particular deficiencies in technical skills, maintain student motivation, and ensure that students receive adequate support for their studies.

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 is not simply a piece of enterprise level software. Woolf is working to create a new economic and social relations within an accredited, blockchain-enforced framework. We believe this is essential because we believe that the values to be encoded in the 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.

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, non-profit, borderless, public-spirited values our platform will seek to encode, have the potential to significantly benefit higher education, and will make Woolf superior to the potential alternatives, and better for the future generations of students. We hope that Woolf secures a first-mover advantage so that a less democratic, less credible, less charitable alternative will not come to dominate the sector and ultimately provide less of a benefit to society.

It is for these reasons, and in close discussion with our legal counsel, that we have chosen to use the sale of tokens as a tool for raising capital. It is our desire that this be conducted in a professional, orderly, and honest manner.

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 \$269bn, with the top 18 currencies capitalised over \$1bn, and the top

4 capitalised over \$10bn. More than 160 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.

WOOLF is the service medium for relations in a partially decentralised market. The link between smart contracts and the utility token helps to ensure that all parties fulfil their contractual obligations. In the first instance, that is the obligation for teachers and students to undertake their tutorials, but it also includes a number of administrative processes, and teachers in some jurisdictions may eventually have their taxes automatically calculated and deducted.

4.1 The WOOLF Protocol

Woolf is releasing a token over the Stellar network. Woolf will use simple 'smart contracts' on the Stellar network for the basic management of the token, whereas Woolf is building complex smart contracts with Hyperledger Fabric that interact with the Stellar contracts and the Stellar-based token. Thus in our design stack, the heavy lifting is done on Hyperledger Fabric and the value is managed on Stellar. By dividing the work between Hyperledger and Stellar, Woolf supports a sophisticated smart contracts and extremely low transaction costs.

In fact, Woolf is not finally committed to any specific blockchain platform 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 student and faculty experience, and we are sensitive to costs, security, and self-sovereign identity.

Given the rapid pace of blockchain coding advancements, particularly in the area of interoperability and throughput, our underlying code is likely to change as the technology matures, and we intend for our network and the identity of our token to outlast any underlying code. We have thus outlined a strategy for managing any need arising which might move us off of a particular network, and this can be read in 6.1 The Woolf Reserve.

4.2 WOOLF in Practice: Payment Stability

Woolf will use a single utility token called WOOLF to manage custodianship of student tuition. WOOLF integrates with a network of smart contracts that will help the university to enforce regulatory compliance for degree accreditation, reengineer or automate administrative processes, and reduce overhead costs.

One of the core utilities planned for WOOLF is the check-in smart contract. A student's WOOLF is placed into the check-in smart contract and thereby books a future tutorial session. Later, the contract discharges WOOLF to the teacher or to the student: when the student and the teacher both check-in correctly, then the smart contract allocates academic credit to the student and WOOLF to the teacher. WOOLF is automatically discharged to the teacher in some cases when the student fails to attend, or to the student if the teacher fails to check-in.

¹³ <https://coinmarketcap.com/all/views/all/>

The check-in contract itself will be linked to a range of services related to student and teacher feedback, course progression, and quality assurance; but these are outside the scope of the current analysis.

The discussion here is concerned to show how the value of WOOLF payments from the smart contract can be stabilised, so that the price volatility of WOOLF does not adversely affect participants. Since one WOOLF always has the value of one WOOLF, and is stable with respect to WOOLF, any talk of price or value or stabilisation is only possible when measured against external referents. Stabilisation can only mean something with reference to an external value (like a ETH or XLM); this is especially important because the teaching programmes at Woolf are designed to reach across borders and jurisdictions, some of which may reference values of high volatility.

For Woolf, token volatility is generally expected to be a concern for teachers and their colleges, rather than a matter of concern for students. This is because students are meant simply to purchase whatever number of underlying WOOLF are required to denominate the advertised value of a teacher' or college's tuition. For example, the student purchases \$100 USD worth of WOOLF using XLM.

Several methods are available for stabilising the value of payments in a token like WOOLF against the value of external referents, including crypto currencies like EURS, TrueUSD, Tether, or DAI. Here we discuss two relatively conservative methods of payment stabilisation; our methods locate the stabilisation mechanisms outside the token itself, so that adjustments to the mechanisms are not required of the token's own protocol in order to improve stabilisation techniques.

At Woolf, we have chosen to make stability a feature of smart contracts rather than a fact about the number of tokens or their internal protocol. Alternative methods not discussed here would include, but are not limited to, burn-mint mechanisms, forward contracts, and a central stabilisation fund (directed either at contracts or the market as a whole).

Each of our two methods stabilises the value of a local payment in WOOLF without stopping the overall fluctuation in WOOLF's price. *To repeat, the strategies outlined here do not attempt to stabilise the fluctuating price of WOOLF against other values or currencies, but stabilise the value of a payment in WOOLF to a teacher. We manage value stabilisation against an external referent by denominating that reference value in WOOLF.*

Our methods of value stabilisation have precedents in the stable coin DAI (Method One) and in the Abra wallet (Method Two); the Abra wallet uses 'synthetic currencies' to manage counter-party risk by denominating multiple external values in a single token across customer wallets.¹⁴

¹⁴ Bill Barhydt, CEO of Abra, 'In the current down market ... Abra's system worked perfectly and we didn't lose a penny and were still able to make the consumer whole.'
https://www.reddit.com/r/litecoin/comments/893hdq/abra_ama_with_ceo_bill_barhydt_starting_now_3pm and
<https://support.abra.com/hc/en-us/articles/360001818392-How-do-Abra-s-synthetic-currencies-work->

There are four entities described here. (1) Colleges: these are the first five colleges of Woolf, which are each endowed with pre-allocated WOOLF. Future colleges must accumulate their own stabilisation funds or request the service of another college or vote to form a collective stabilisation fund. (2) A 'check-in smart contract' is an agreement between (3) a student and (4) a teacher. The smart contract holds WOOLF (and only WOOLF) from the student that is to be paid to the teacher upon completion of teaching, or returned to the student if the teacher is negligent.

'Token velocity' just means the length of time that a token is retained after acquisition.¹⁵ The assumption here is that, other things being equal, increasing token velocity tends to lower token price, and decreasing token velocity tends to raise token price, since the latter maintains a reduction in circulation. In short, it is typically better for the price of WOOLF if it is locked into smart contracts for longer.

4.2.1 Method One

Method One significantly reduces token velocity in anticipation of future price volatility. It incentivises colleges to build a large reserve of WOOLF in order to stabilise payment values denominated in WOOLF within a bounded range of volatility, whenever paid from the college's check-in smart contracts. For Method One, the greater a college's stabilisation fund, the greater the range of volatility it can stabilise. At the time of execution, Method One does not require significant external relations, though it must correctly report an external exchange rate of WOOLF against the value that is stabilised.

Method One functions by having the teacher's college match the WOOLF in a smart contract with some multiple of WOOLF and add this extra WOOLF to the smart contract; the smart contract then pays out WOOLF at a rate intended to achieve an equivalent value to a chosen external currency, rather than according to an agreed number of WOOLF. If the value of WOOLF declines, the smart contract pays out more WOOLF, up to the combined total of the student and college's contribution and no more. If the value of WOOLF rises, surplus WOOLF are returned to the college's stabilisation fund.

It is expected that whenever stabilised payment is voluntarily selected, the agreement will stipulate that the smart contract will pay out at the rate of an external value, denominated in WOOLF, up to the maximum amount of WOOLF in the contract, rather than a specific number of WOOLF. The method itself does not determine which external value is denominated in WOOLF, though relatively stable referents are envisaged (e.g. Tether, gold, EURS, etc.). Method One is similar to DAI in some respects, but relies on a single token.

Method One provides the college's stabilisation fund with an upside potential, since more WOOLF could be returned to the fund than were used to stabilise the contract, if fewer WOOLF are required to meet the value payment. However, Method One can only offer bounded downside protection, and it may adversely contribute to general

¹⁵ See Kyle Samani, 'Understanding Token Velocity,' Multicooin Capital 8 December 2017. <https://multicooin.capital/2017/12/08/understanding-token-velocity/>

market volatility by conserving WOOLF when its price rises and by discharging WOOLF when its price falls (though it does not determine whether these discharged WOOLF are in fact traded on any secondary market or in fact held by a teacher).

4.2.2 Method Two

Method Two, like Method One, incentivises colleges to build a reserve of WOOLF in order to stabilise the value of the smart contract; this decreases token velocity. Method Two would require external exchange relations, whether manually or through an automated API. In Method Two, a college manages counter-party risk by exchanging WOOLF from its own stabilisation fund, on a market, in real time, whenever a 'stabilised payment' smart contract is capitalised with WOOLF.

Method Two is like a forward contract, except that the college actually exchanges its own WOOLF for another token, and the teacher's check-in contract actually agrees to purchasing the college's newly acquired token (reconverted back into WOOLF as needed), thereby fully replenishing the college's spent WOOLF from the WOOLF-denominated stabilisation fund. The college recovers all of its WOOLF whenever the smart contract of the relevant parties is executed; the teacher receives a payment at the original value selected, now denominated in WOOLF. Although the number of steps is increased compared to Method One, the steps are relatively easy to automate, and no oracle is required to report accurately on exchange rates, since price discovery is determined by a transaction that is fully executed.

Method Two reduces token velocity in anticipation of future volatility and in anticipation of student numbers, for which a college builds its stabilisation fund; but Method Two increases token velocity at the time of execution – since (roughly) a student purchasing 1 WOOLF triggers the college to sell 1 WOOLF. For Method Two, it is thus only the anticipatory accumulation of WOOLF that slows token velocity, rather than the increase in student numbers. This may be generally more beneficial to the overall stability of value of WOOLF.

Method Two caps downside risk by purchasing the final value to be discharged from the check-in smart contract. Method Two does not by itself provide any upside potential for the college's stabilisation fund, since all of the WOOLF in the check-in smart contract will simply replace the WOOLF spent by the college's stabilisation fund, when it purchased the external value, even if that external value is re-denominated in WOOLF before being sent back to the check-in contract.

4.2.3 Comparison of Methods

Method One

Pro: supports the overall price of WOOLF because colleges must build large reserves at a multiple of the college's WOOLF usage.

Pro: potentially increases a college's stabilisation fund

Pro: requires minimal external relations

Pro: token velocity – an additional multiple of WOOLF taken out of circulation per student.

Con: market stability – may sell more WOOLF than purchased by students.

Con: it offers bounded stability if the value of WOOLF goes down.
Con: teacher will receive fewer WOOLF if the value of WOOLF goes up.
Con: requires colleges to have built a large stake of WOOLF.

Method Two

Pro: supports the overall price of WOOLF because colleges must build reserves, though not greater than the college's WOOLF usage.

Pro: high stability in bearish markets or for classes scheduled far in advance.

Pro: market stability – broadly does not sell more WOOLF than a student has purchased.

Con: token velocity – not as much WOOLF taken out of circulation per student as Method One.

Con: it requires external relations and potentially trust. College relies more on teacher performance.

Con: teacher will receive less WOOLF if the value of WOOLF goes up.

Note: our default setting is a combination of Method One and Method Two, managing downside risks with limited upside potential.

4.2.4 Token flow overview

1. Student joins the Woolf platform; profile and wallet formed.
2. Student applies to one of the first five colleges and is accepted.
3. Student and teacher agree to the parameters of the check-in smart contract.
 - a. Teacher chooses to forgo precise payment in WOOLF by selecting 'stabilised value payment'.
4. Student purchases WOOLF for the check-in smart contract
 - a. Student sends WOOLF to check-in smart contract (through college website).
5. Stabilised payment request triggers the college's Stabilisation Fund to enact Method One, Method Two, or a combination of both methods
 - a. Method One: college places its own stabilising WOOLF into the check-in smart contract.
 - b. Method Two: college exchanges its own stabilising WOOLF for teacher's desired token.
6. Check-in smart contract pays out, following Method One and/or Method Two. If Method Two, then payment to teacher would be made either in chosen token, directly to teacher upon receipt of teacher's WOOLF; or the chosen token would be exchanged back to WOOLF and sent to the check-in smart contract at time of discharge, including situations wherein the teacher has failed to check-in and WOOLF is returned to student.
7. Teacher in receipt of tokens exchanges, holds, or pays for further services.

4.4 Utility in The Tutorial 'Check-In'

The first and most basic transaction on the Woolf network is the 'check-in' for a tutorial. The smart contract requires the token to be formed, and the logic of the smart contract is enforced by the exchange of the utility token. When both parties check-in to the tutorial, they agree that it has begun. This executes the smart contract: the teacher is allocated payment for teaching and the student is indelibly recorded with academic credit for the tutorial.

Woolf will be geographically agnostic and medium agnostic. A student and teacher might 'check-in' when starting a discussion over a video-calling programme like Skype or Zoom, or when meeting in person. The smart contract might delineate the terms of the meeting, such as date, time-zone, and timeframe. It is anticipated that 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. To an extent, the stipulations of a smart contract are a matter of university policy for enforcing regulatory compliance towards degree accreditation, but many parameters are a matter of college policy.

The most basic utility of WOOLF will be as simple as two people clicking a button on the platform application. Although this shows the minimum utility of the token, we aim to see a network built with the democratic 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 university education.

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 designed to provide a progressive and regulated 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 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 (The Woolf 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. It may be notable that aspects of the future development of the network will thus be outside of the managerial responsibility of Woolf Development.

Utility in a token is not bound to a single software protocol. A token could have its underlying code swapped if a superior protocol will enhance utility for the network. Whether such underlying changes in the coding amount to an 'exchange' of tokens will pass entirely unnoticed to many users, for whom it is little different than updating computer software, but such updates must be conducted in a transparent and orderly fashion. 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.

5. Legal Entities

We envisage that 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 WOOLF, or the Woolf blockchain network which may be colloquially referred to as 'Woolf University'.

Colleges are digital entities appearing on the Woolf website. The colleges of Woolf University have no legal significance to Woolf, but some colleges will be related to a legal entity in other jurisdictions – existing brick-and-mortar colleges and universities will be permitted to join the platform and gain access to a global network of students and teachers if they comply with the framing rules of the network.

Woolf Development Ltd is an entity established to launch the Woolf blockchain network. It is responsible for developing the technology platform, gaining accreditation for the university, and organising the first five colleges. Woolf Development Ltd will licence and donate intellectual property to the Trust.

Woolf Development Ltd will be the issuer of tokens at the token sale, and it will be the recipient of their proceeds, which will be dedicated to software development, paying the salaries of the retained faculty members and development team, and endowments the Woolf Trust and the colleges (10.2 Proceeds from the Token Sale).

The University is democratic, but only the Trust has the right to carry out the wishes of the faculty votes, and the Trust is constrained by its bylaws. The Trust assigns its demands to any assignee or subcontractor, and Woolf Development is expected to be a principal partner fulfilling the wishes of the Trust.

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. It is envisaged that in four years, pending legal counsel and a simple majority consensus of the network faculty members, Woolf Development will hand over university governance to the non-profit company, The Woolf Trust.

The Woolf Trust will be subject to democratic procedures and bound to fulfil its non-profit mission of developing Woolf University. The legal jurisdiction of the Woolf Trust will be determined after having considered legal advice from different jurisdictions. The bylaws of the Woolf Trust will be drafted in the jurisdiction of the Trust. The Board of the Trust may assign the implementation of its responsibilities to various committees or third parties, and in exceptional cases a faculty vote in the Faculty Council may veto these assignments (7.1 The Faculty Council).

If the Faculty 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 Faculty 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).

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 counsel. 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 counsel and liaise with the academic advisors.

The academic advisors will be retained with a view to forming 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 tutorial teaching; these will be 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 Ambrose.

(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. Internal quality assurance mechanisms will be harmonised with the requirements of our government regulatory partners and enforced by the parameters of the blockchain smart contracts.

5.3 The Woolf Trust

We expect the Woolf Trust to 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 Faculty Council (7.1 The Faculty Council). It will be one of the largest holders of WOOLF 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 will be 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 Woolf Trust is tasked with 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 to adapt their social practices to comply with the smart contracts of the Woolf network, and appropriately capture the data needed for accreditation.

Administration. The Trust will fund, subject to annual University approval, 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 include members of one of the world's oldest universities and 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 normally 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 Faculty Council, can increase the emissions rate of the Reserve above 0.099%. In other words, the reserve may only ever emit tokens at a monthly rate below one tenth of one per cent. At this rate, meaningful token emissions will continue for centuries.

6.1.2 The Woolf Reserve Blockchain Migration Policy

The second mission of the Woolf Reserve is to prepare the network for the possibility of a fundamental change of its own blockchain technology. 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, blockchain, or distributed ledger technology. The pace of developments in blockchain technology is rapid, and the University may require its own blockchain, or may experience immediate significant benefits from moving onto another blockchain.

Such a practice has become increasingly common, it is expected to become more common, and it need not incur major costs. Under conditions of a new blockchain, however, the Woolf network's consensus algorithm could demand that a portion of funds in the Reserve be reallocated in line with a new consensus protocol (e.g. as mining or validator rewards). We thus reserve funds for a migration onto a new blockchain. The good of the University and its members must prevail in any decision making process, and even a significant reduction of the Reserve would still see it capable of effectively funding development projects over the next century, if the market value of WOOLF remains supported.

The Woolf Reserve cannot be used for any other purpose. During the phase in which Woolf Development retains managerial control, any move to a new network we understand to require the approval of the Trustees of the Woolf Trust, and be in accordance with Trust's bylaws in its home jurisdiction. Once authority has been passed from Woolf Development to The Woolf Trust, the move will be made solely at the directive of the Faculty Council and implemented by the Trust within the constraints of the Trust's bylaws.

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. Anyone with valid documents meeting the requisite criteria may start their own college on the network platform or apply to join an existing college. Criteria for college formation and faculty membership are subject to democratic consensus (7.1 The Faculty Council).

Woolf is open admissions for qualified faculty members and selective admissions for students seeking degrees. 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 (7.4.1 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 are designed to incentivise best practices. 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 (namely in the Tuition Bidding Pool).

Woolf University will seek to be administered 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 (7.4.2 The Administrative Bidding Pool).

6.3 The Colleges of Woolf University

University rules constrain the formation of colleges. A quorum of 25 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'.¹⁶ 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 in WOOLF. This will make it possible to provide payment stabilisation (4.2 WOOLF in Practice). It will also 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.

¹⁶ https://www.timeshighereducation.com/world-university-rankings/2017/world-ranking#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats

6.3.1 The College Template

We want the process of starting a new college to be as painless as possible, and ultimately to allow everyone to participate in a global network.

After five colleges have been created, Woolf will become open admissions for faculty members and selective admissions for students. Our aim is for every qualified academic professional in the world to be permitted join the university. Any new faculty member, once their research doctorate has been verified, may apply to join a college; any group of thirty or more academics will be allowed to form a new college on the digital platform and begin teaching students for ECTS credit. Teaching methods and degree programmes must meet our internal quality assurance checks, which are being developed in coordination with our regulatory partners, and encoded into our blockchain.

Starting a college should demand equal or less bureaucratic work compared, for instance, to organising an academic conference. Smart contracts are designed to protect college members (both students and faculty) in a non-profit environment and to provide predictability and stability of employment for faculty, in addition to accessing the global network.

In our current technology stack, the user website is coded to be scalable in order to facilitate serial growth. On the website, the College Template will interact with the underlying blockchain (Hyperledger Fabric), which in turn engages with Stellar for value transactions. The template allows a faculty group to upload their own profiles and display their course offerings, which present students with an attractive and organised site to explore the college in a visual layout that is familiar across the University. This kind of scalable template is typical of any major 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, and they can engage with the course creation tool to create compliant course syllabi in harmony with our regulators. If a quorum of the faculty members forming the new college are already members of an existing 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.

The College Template contains parameters that must be distinguished from the University rules that constrain all colleges. The College Template's parameters can be partially revised, 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 first full template and work with the blockchain engineers to integrate it with the blockchain's smart contracts.

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 fiat stipend 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 2 essays per week for 3 years. The academic year at Woolf consists of 3 terms of 11 weeks, during which at least 8 weeks concentrate on tutorial teaching. Terms conclude with a summative assessment.

Tutorial teaching consists of small classes of one to three students studying directly with a professor (the 'tutor'). Tutorials are used both in the natural sciences and the humanities. Preparing for a single tutorial takes 2-3 days. A student must review about 100 pages of material (depending on the subject) and prepare a piece of written work – whether a mathematical problem or an essay. The student must then be ready to discuss and defend their written work directly with a professor for 75 minutes. At the end of the tutorial, the professor tailors the next assignment to the student's weaknesses and interests. At Woolf, like at Oxford, doing this twice per week is a full workload.

All courses offered by Woolf are designed to be conducted either online or in person. Students and faculty must use the Woolf app to capture teaching data, such as starting a tutorial or submitting an essay, but this process works identically whether the teaching is online or in person.

Ambrose will encourage its faculty to produce lectures to complement each of their weekly tutorial sessions. 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 teachers by raising their visibility, and by raising the profile of the college.

We will form an on-boarding team to help the university scale as it receives a high volume of faculty and student applications, as well as reviewing institutions that would like to join as colleges. 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 Student 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 a 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. Many degree courses request writing samples or 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 ensuring that the first colleges are composed of top-ranked academics, 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.

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 allocated to Woolf Development for immediate work, and Woolf Development allocates funds for long-term development projects to the Woolf Trust and where possible as college endowments. 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 Faculty 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 Faculty Council, and no one else is a member of the Faculty Council. Only eligible faculty members can vote. Faculty members are eligible if they hold a research doctorate and 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). University governance will be conducted by digital voting in the Faculty Council. Possession of WOOLF is not a criterion for voting eligibility.

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.

We envisage that the Faculty Council will have the authority to change any network-wide rule in the University, including the network-wide rules that minimally constrain all colleges, the budgetary procedures, and the rules that determine the Reserve emission rate (up to its maximum of 0.099%, 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 Faculty Council directives and cannot violate its bylaws. The Faculty 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 Faculty Council may specify, within the constraints of the Trust's bylaws, that the Trust unlock the Woolf Reserve and allocate funds to a new blockchain. This is the only procedure and the only condition under which the Woolf Reserve can be unlocked.

Initiating a vote in the Faculty Council on most topics 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 Faculty Council actions. Examples of online-petitions with user interfaces are common.¹⁷

7.2 The Monthly Budget Vote

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

Unlike the Faculty Council, the monthly budgetary votes do not require an overall majority, but are simply ranked by popularity, and must at least meet a minimum threshold of support to be eligible for funding. Proposals meeting a threshold of 30% 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. Any proposals above the threshold, after payments have been exhausted on more popular proposals, will not receive any funding.

Unlike the Faculty 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

¹⁷ <https://petition.parliament.uk>, Change.org, etc.

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.

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 should 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.

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 Faculty Council), the University budget is funded by several possible means, which are subject to Faculty Council revision. This includes the following:

(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 Faculty Council. A percentage of the proceeds of the surplus may be deposited in the Woolf Reserve.

(2) The Woolf Reserve will allocate up to 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 Faculty Council may increase the maximum allocation but cannot exceed 0.099%.

7.3 University and College Awards

The Woolf platform is designed to provide regulators with clarity and confidence about the compliancy status of teaching within Woolf. This is essential for a borderless university. We have been working closely with regulators to ensure that teaching will be accredited at Woolf without regard to geography or national affiliation.

Woolf will provide a profile of the data relevant to accreditation and compliancy status – in real time and at almost any level of granularity. By using a blockchain, Woolf can manage sensitive personal and financial information with banking-grade security. The

platform is designed to offer students and teachers uncompromised custodianship of their personal data. We are serious about the European Union's Data Protection Rights.

Woolf has been offered a clear pathway to full degree-granting powers in Europe within 6 months of submitting an application. We have worked closely with regulators on the structure and timing of Woolf's accreditation. Members of Woolf's Leadership Team have acted as expert advisors to government regulators on the accreditation of programmes, and members of Woolf's Advisory Board have been responsible for overseeing the establishment of several universities.

We view accreditation as a minimum standard, and a Woolf education is designed to go beyond mere regulatory requirements to ensure a globally-recognised standard of academic excellence.

Woolf will be governed by rules encoded in the blockchain, framing relationships across the entire network. University-wide rules delineate the criteria by which University degrees are awarded, and those criteria to be embedded in smart contracts which enforce compliance in harmony with our regulatory partners.

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 *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 Faculty Council vote may eventually 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, and our

use of the European Credit Transfer System (ECTS) will position us for the widest global reach possible.

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 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 of their network activities. Data is either compliant or it is not captured, and if it is not captured it does not accrue to a student's accredited record of achievement. 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 may offer benefits to the Woolf community as a whole and 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 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.

7.4.1 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 are 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.

7.4.1.1 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 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 a global pool of accredited teachers and a global talent pool of students will be no more difficult than any of the existing options, even if it must blend features from several of them.

7.4.2 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.

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.

7.4.3 The Peer-Review Bidding Pool

We believe the current methods of academic peer-review are ripe for improvement. Poorly compensated reviewers, protected by anonymity, 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.¹⁸ 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. Blockchains provide new opportunities for peer review. Hyperledger Fabric has already been used to create triple blind identity information queries for Canadian banks. 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

¹⁸ <https://www.theguardian.com/science/head-quarters/2015/mar/12/games-we-play-troubling-dark-side-academic-publishing-matson-sigafoos-lancioni>

satisfying sufficient similarity of classification can review each other's work. So for example, a teacher with a record of 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 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, some scholars may 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, or a third party acting to intermediate between them.

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 and frivolous 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 tendency 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.

7.5 The Woolf University Press

The Woolf University Press would be 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). It is not discussed further in this white paper.

8. Revenue and WOOLF Valuation

Student tuition is one key driver of value for WOOLF. 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 in high quality classes, including tutorial with professors. The student and the professor can connect without intermediaries and without high levels of 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 aims to facilitate the delivery of high quality education at an affordable cost. Woolf aims to achieve efficiencies by removing intermediaries; one of the areas of savings we have identified is the middle layer of bureaucracy between the classroom and the regulator. Similarly Woolf aims to coordinate the academic market better by placing all of the players in the same network and providing tools to more accurately connect people in an accredited environment. Woolf also creates efficiencies in the management of certification, the custodianship of sensitive personal and financial data, and a number of other areas.

As an institution, Woolf will not set a global price for tuition; however, it recommends that its member colleges set their tuition price in-line with or below public British and American universities. This is a matter of college policy, rather than university policy. Global tuition fees, and global salaries, will reflect the overall profile of the college, including the cost of living for its teachers (which depends on geography), the prestige of the institution, and its financial resources for scholarships. Moreover, Woolf intends eventually to admit brick and mortar institutions onto the platform, and their costs will reflect their own infrastructure.

A high quality, personal education benefits from starkly different demands on students and teachers. As described above (6.3.2 The First College: Ambrose), a single tutorial lesson demands 2-3 days of work from a student; however, it requires an hour or less of preparation for an experienced teacher. As a consequence, a fulltime workload for a student consists of 2 tutorials per week, whereas a fulltime workload for a teacher consists of 7, 8, or occasionally 9 tutorials per week. The asymmetrical workload, combined with other efficiencies, is designed to allow tuition to be affordable for students even while salaries are attractive to teachers.

Consider Ambrose. (We quote prices here in pounds for context.) In order to protect its high teaching standards and the high cost of living in the United Kingdom, the

College has all faculty members charging £250 (\$330) per tutorial across 9 tutorials per term, which amounts to 54 tutorials per year for students. This figure may be changed by a democratic consensus in the College, and Ambrose may 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		
£150	£8,100		
£200	£10,800		
£250	£13,500		
£300	£16,200		

Each of the above rates assumes there is only one student in the class. Here we show the same teacher revenue per tutorial, but with *two students* in each tutorial:

Charge per tutorial	Annual Tuition		
£150	£4,050		
£200	£5,400		
£250	£6,750		
£300	£8,100		

From an international student’s perspective, Ambrose is competitive without scholarships. International fees in the United Kingdom for Russell Group universities typically start at £15,700, and go up. Fees in this range (\$20,858), are comparable to American state university tuitions.

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, 8 tutorials per week at Ambrose would generate £54,600 per year, assuming the teacher conducts tutorials with only one student per session and teaches only 3 terms per year, or 33 weeks. A teacher might provide 7, 8, or 9 tutorial hours per week. Here are 3 potential workloads for a teacher who has *one student* in each tutorial and their effect on annual salary:

Charge per tutorial	Tutorials per week: 7	8	9
£150	£28,350	£32,400	£36,450
£200	£37,800	£43,200	£48,600
£250	£47,250	£54,000	£60,750
£300	£56,700	£64,800	£72,900

Some members of Ambrose may elect to teach more than 8 tutorials per week, and many members will elect to teach beyond the three terms of the academic year, since

these cover only 33 of 52 weeks. Others will be satisfied to pursue their own research interests, potentially on funded projects.

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 £150 (\$200); this would reduce the annual tuition below the typical annual fees charged by major British universities, which are £9,250 (\$12,289) per year, or £170-190 per tutorial, depending on course structure. (British universities require fewer hours of study per credit than most European universities, and thus Woolf's academic year is longer than what is found in Britain.) 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.

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 not a problem when the members are all physically present in the same room, but it requires extra attention if conducted over a platform like Zoom or Google Meet. The financial benefits are obvious, however, since a tutorial with 2 students might lower student fees while dramatically increasing teacher salary.

As the University network matures, local students will be more readily available to local tutors. Progressive network saturation would provide new opportunities – not only local tutors but also opportunities for local student clubs.

8.2 WOOLF Valuation

WOOLF has fundamental value drivers beyond speculative trading in a secondary market. Here we will consider just one of those: the tuition held in WOOLF smart contracts.

The most prominent addition to the value of WOOLF would consist of the demand to hold tuition in smart contracts. If 1 college with 100 academics teaching their students one-to-one, and if the academics teach only 7 hours per week, three terms a year; then the college is teaching 700 tutorials per week, 9 weeks a term, 3 terms a year. A student with a full workload requires 2 tutorials per week, and thus the college can teach 350 full-time students. The students pay the equivalent of \$330 per tutorial, or \$17,820 per year.

On day one, the college has the equivalent of \$6.24m locked in WOOLF smart contracts and thus the total capitalisation of WOOLF is \$6.24m, excluding other factors. If 50 such colleges join Woolf, then the value of WOOLF will be \$312m on day one of the academic year, excluding other factors.

Three notable forces then decrease the capitalisation of WOOLF smart contracts:

First, the above calculations consider only the first day that contracts come into force. Yet WOOLF smart contracts lose funds as they pay out salaries to its teachers, who may be exchange for some other currency, since every tutorial triggers the smart contract for 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 (barring other factors).

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 \$17,820 in tuition, and although we foresee (but do not promise) many colleges charging much more, many could also charge less.

Nevertheless, as the network grows we would expect smart contract capitalisation for tutorials to become more steady for three reasons: (1) more colleges will help their teachers to ensure that they have a full portfolio of capitalised, future contracts covering the year(s) ahead, (2) a variety of overlapping academic calendars and course plans would integrate with the platform, and (3) 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) engage in language exchanges on the platform.

8.3 Target Market

How many users can Woolf University acquire? Above we described 50 colleges comprising 5,000 faculty and 17,500 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 solution, which is the first blockchain-powered university, which is open admissions for faculty and selective for students, using smart contracts to enforce regulatory compliance across borders. We believe that the democratic principles and revolutionary employment practices of Woolf position it to make significant and beneficial 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 63 million academics have signed up to Academia.edu, adding 21 million papers. Academia.edu attracts over 19 million unique visitors a month.'¹⁹ Similarly, Researchgate.net claims more than 15m users.²⁰

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 1.26m students. If their smart contracts only ever held 5% of the \$17,820 annual tuition, the capitalisation of the smart contracts would be over \$1.12bn. If their smart contracts only ever held 25% of our \$19,200 annual tuition, the capitalisation of the smart contracts would be \$5.61bn.

If Woolf achieved 2% of Researchgate.net's users, there would be 300,000 users. If each user had a single smart contract, and their smart contracts only ever held 10% of our \$17,820 annual tuition, the capitalisation of the smart contracts would be over \$535m.

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. 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 a background for the top universities, 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 to offset start-up costs as the network grows. The colleges will also be provided with WOOLF scholarships used to attract students. The Woolf Trust will prepare its infrastructure for all eventualities of WOOLF market capitalisation and valuation.

¹⁹ <https://www.academia.edu/about>

²⁰ <https://www.researchgate.net/about>

It is our desire for Woolf University to reach the most able students regardless of their financial circumstances or location. 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 several conditions including 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 that 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, since 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

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 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. All token purchasers will have to pass KYC and AML/CTF checks. Citizens of the United States, the People's Republic of China, North Korea, and the Islamic Republic of Iran will not be allowed to participate in the sale.

Pricing per token and other details are available with the sale documents.

10.1 Token Allocation

WOOLF is a pre-mined Stellar 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 0.035% of the Reserve tokens can be released from the Reserve per month, and 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 link 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. 4bn (4,000,000,000) tokens are minted, but 2bn are locked in the Woolf Reserve, and 1.2bn are put in the Woolf Trust and Woolf Development

(subject to long vesting periods). The details can be seen below. This leaves 800m WOOLF (or 20%) for the token sale.

The forecast of token circulation can be seen in the Token Paper – the rate at which tokens enter circulation is conservative. The monthly emission rate from the Woolf Reserve is 0.035%, assuming that budgetary proposals receive adequate democratic support, but it will be less if 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 (locked) 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 activities (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 subject to voting procedures. The pricing per token, which will officially be in XLM, is detailed in the sale documents. The breakout of raised funds is as follows:

35% – Core Leadership Team and their employees

Core Leadership. This is a crucial university development budget. The Core Leadership Team is responsible for the core development of the software platform of the university. Core Leadership includes the founder and Director (Dr Joshua Broggi), the Technology Director (Mr Johann Lilly), and the Programme Directors (Dr Jonathan Duquette and Mr Martin Gallagher). These funds are used by the core leadership in expanding the staff of Woolf Development by hiring blockchain engineers, cloud architects, network administrators, product engineers, big data administrators, React and UI/UX software developers, and consultants. Core Leadership also oversees further contracted and subcontracted legal counsel, accountants, on-boarding specialists, regulatory experts, and media consultants.

25% – Retained Academics capped at 40 academics for 4 years)

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 fiat currency derived from the token sale for a period not longer than 4 years. The initial number of academics is set at 20 but is subject to token sale proceeds; the number may be increased to 40 to prepare academics for supporting the second college. The responsibilities of the academics during their 4-year tenure include 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) working closely with 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 growth. It is assumed that the initial academics will increasingly choose to take their salaries in WOOLF after the first year, especially if the network has met key milestones of development. 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.

40% – Institutions

12.5% – The Woolf Trust

12.5% – Endowment of the first colleges

7.5% – Media

7.5% – Legal

Institutions. The network's institutions' first requirement is to be established and safeguarded by developments from core leadership, but provided those are secured, they require endowment, and together with its members, they require legal counsel. A media campaign will begin before the first college opens and seek to bolster the reputation of these institutions.

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

II. 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, supporting the relation between students, teachers, and their colleges; (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 an elegant user interface, 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.

Woolf Development Ltd is on the forefront of new regulatory and technological arrangements. This makes the timing of milestones less certain – please be prepared for delays or alterations to the roadmap. Features of the roadmap could be further revised by democratic consensus. It remains useful to outline here a scalable process in which the essential services are prioritised and future projects are identified for action.

What follows is a provisional timeline:

2018 Q1

1. Legal counsel retained.
2. Woolf has core positions filled.
3. White paper has many rounds of review.
4. Woolf website launched and white paper published.

2018 Q2

1. Accreditation discussions with government regulators.
2. Platform beta-testing on the blockchain.
3. Number of Woolf Advisors doubled.
4. Media coverage increased.

2018 Q3

1. Fundraising.
2. Full accreditation application submitted to government.
3. Technology stack announced.
4. Token sale announced.

2018 Q4

1. Accreditation achieved.
2. New hires and team expansion.
3. The first college, Ambrose, is launched.
4. The platform continues development.

2019 Q1

1. Degree-seeking students accepted by Ambrose.
2. On-boarding team is formed to help new colleges.
3. Colleagues at Cambridge invited to form second college.
4. Platform improvements focussed on user experience.
5. Academics produce tutorial lecture videos.

2019 Q2

1. Launch of new colleges.
2. Faculty growth across university.
3. Monthly budgetary voting given new App interface.
4. The Tuition Bidding Pool is integrated with the blockchain.
5. Document verification process optimised.

2019 Q3

1. First five colleges filled.
2. Faculty recruitment campaign launched.
3. Student recruitment campaign launched.
4. Administrative and Peer-Review Bidding Pools are opened.

2019 Q4

1. Faculty Council voting is integrated with the blockchain.
2. Onboarding team increased.
3. First five colleges have a pipeline of students in smart contracts.
4. The Woolf Trust led by a significant figurehead and experienced board.

2020 Q1

1. College formation is open beyond the *Times Higher Education* top 200
2. A Language Exchange School is opened.
3. Student services continue improvement.
4. Real estate under review for college sites and annual seminars.

2020 Q2

1. The Woolf Trust identifies a major research initiative to fund with media coverage.
2. Onboarding team for brick-and-mortar institutions formed.
3. The first brick-and-mortar college integrates with the network.
4. Expanded student society support and real estate.

2020 Q3

1. Action plan for the Woolf University Press is drafted.
2. Woolf expands media offering of recorded lectures to complement tutorials.
3. Woolf Development Ltd consults with academics on timeline for passing authority to the Woolf Trust and becoming an assignee of the Woolf Trust, which is under the authority of the Faculty Council.