

## VIRTUAL PROGRESS: SIMULATING ECONOMIC DEVELOPMENT ONLINE

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### ABSTRACT

*In 1999, Cannon, Yaprak and Mokra presented their description of Progress, a non-computerized game, developed initially to teach students from former communist countries the economic consequences of free-market principles. While the game appears to have had conceptual merit, it has proved difficult to administer in practice, both because of the administrative burden of recording player interactions and because of the time required to play the game. Given these problems, combined with the desirability of being able to administer the game simultaneously in multiple locations (different countries), the game appears to be a natural candidate for online education. This paper describes an Internet-based game that incorporates the basic logic of Progress, overcoming its drawbacks by incorporating the benefits of computer-support, asynchronous timing, and geography-free administration.*

### INTRODUCTION

The classical liberal notion of Adam Smith's "invisible hand" plays a central role in most modern discussions of economic development (Hosseini 1999) and economic well-being in general (Narveson 2003). Therefore, it makes sense that it would feature prominently in both discussions of economic development, and for those who favor simulations and experiential learning, in simulations of economic development as well.

The "invisible hand" appears in two of 2066 papers in the 2004 edition of the *Bernie Keys Library*. One (Gentry, Macintosh, Stoltman, and Wilson 1994) simply mentions it in passing in conjunction with another subject. The second (Cannon, Yaprak, Mokra and Miller 2000) addresses a problem identified by Wolfe (1991), in which he reviewed the use of market-based games in socialist countries. His paper included a list of the typical attitudes of socialist managers that will need to be changed if they are to be effective in a market-driven world. The genesis of Cannon, Yaprak and Mokra's game was related to these issues. It grew out of a program through which their University entered into a cooperative agreement following the fall of the Iron Curtain with a management institute in Ukraine.

The agreement involved a series of exchanges through which American faculty and students would study and work in Ukraine, and an annual delegation of Ukrainian MBA students would come to the United States to study at their university and participate in internships with American companies.

One of the purposes, of course, was to create a better understanding of the similarities and differences between the way business is conducted in the two countries, hopefully enabling both Ukrainians and Americans to broaden their perspectives by combining the best aspects of both systems.

One of the major differences they found was that Ukrainians had a hard time grasping the concept of free enterprise. The problem was not intellectual understanding. The Ukrainian students who participated in the internship program were highly educated and, in many cases, understood the principles better than their American counterparts. However, when it came to managing, they suffered from a mind-set that was dominated by a cultural background that conditioned them to think about economics from a Marxian perspective. That is, economic output was fixed by inputs of capital and labor, and what one party got from this output another must forego.

Contrast this with the entrepreneurial notion that one person's wealth is another's opportunity. In class, then, they would have discussions that went like this: "Oleg, you may not realize this, but you would really like Ludmila to become wealthy. Why? Because if she has a lot of money, she will spend it, and you can get rich by thinking of new products you can sell to her. And Anatoly, you would like them both to become rich, because ... well, you get the idea. You would like everyone to become wealthy, because the more successful other people are, the more successful you can become!"

Again, the concept was not hard for the Ukrainian students to understand. But the conclusion didn't "feel" right. A lifetime of cultural conditioning said, "If they have money, they must have a better job than I do, one that I would rather have." Their mind-set was not to create opportunities, but to seize them; not to help others be successful, but to dominate others as a means to achieving success. The cultural images of success were typically positions of power rather than market achievement, as

Americans might think of it in the context of a free-enterprise system.

*Progress* was developed as a tool for immersing the Ukrainians in a learning environment in which they would be able to experiment with various approaches to economic development, actually experiencing the consequences of cooperation and mutual versus zero-sum success.

In thinking about the *Progress* game, we quickly realized that zero-sum business attitudes are by no means unique to Ukrainians, or even to the Communist dominated cultures of Eastern Europe. They may well have been exaggerated in classes of ambitious Eastern European management students. But the same issues exist for many American students, particularly at our university, where many students are the first of their family to attend college. They typically come from homes that are dominated by a “union” mentality, where labor is seen as being exploited by management, where “jobs” are valued over “economic achievement,” and where rewards earned by either management or labor are seen as coming at the expense of those achieved by the other. This suggests that *Progress* might be useful for American students as well.

As useful as the game might be, in practice, it proved problematic for two reasons: First, the game was very difficult to administer, especially with classes of more than five or ten students. The physical logistics of creating a “market” tended to be very cumbersome, and the clerical problem of checking to make sure all transactions were “legal” and maintaining a log of these transactions was all

but overwhelming. Second, the game required more time than the topic typically merited in most classes.

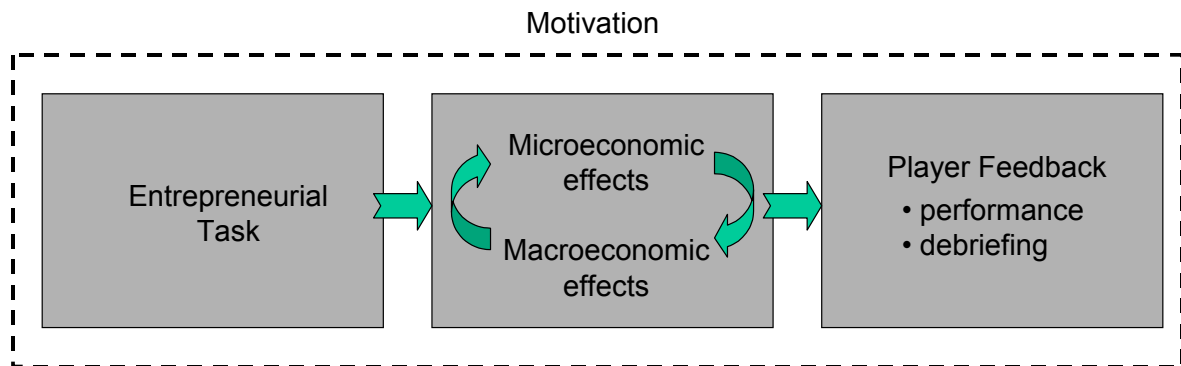
One way to address these issues is to computerize the game and administer it online. Computerization solves the clerical problems, and working in an online environment allows the game to proceed in the background while class time is used for other activities. The Internet has the added advantage of having a relatively well developed set of technology and behavioral protocols (*a la* eBay) for managing online transactions, simulating a true free-market environment. Equally important, it enables the game to be administered in virtually any part of the world, including players from different countries in the same game.

The purpose of this paper will be to discuss how *Progress* might be adapted to a computer-based, Internet environment.

### THE CONCEPT OF THE GAME

Notwithstanding the fact that the theory of free-market economics represents the underlying philosophical underpinnings of most modern economic systems, and certainly all of them that have been relatively successful, its action tends to be very abstract. As we noted in our discussion of the Ukrainian students, one can learn the concepts without having a visceral feel for how the system works in practice.

FIGURE 1: The underlying learning model behind *Progress*



The concept behind the *Progress* game is to create a concentrated experiential environment in which students could see the essential elements of the system working in a concentrated form in real time. The essence of the learning model is captured in Figure 1.

The model suggests five major components: (1) the entrepreneurial task, which immerses students in an actual set of simulated business decisions; (2) the microeconomic effects of student decisions are reflected in the growth in students’ assets, and ultimately in their ability to increase their simulated standard of living; (3) the microeconomic effects interact to create macroeconomic effects, where the

growth of the various student businesses create increasing demand and supply, ultimately reflected in an overall growth in the combined simulated standard of all students; (4) player feedback, coming in the form of individual and collective performance indices, followed by debriefing to help students understand the key elements of what had transpired in the game; and (5) motivation, or the energy supplied by the experiential nature of the design, which, in turn, intensifies the learning experience, increasing involvement and learning.

### The entrepreneurial task

We will dedicate most of the paper to addressing the details of the entrepreneurial task, as we discuss how the *Progress* game might be adapted to the Internet. The thrust of it, however, is that students begin as individuals (or teams), each receiving a unit of labor every period. If they so choose, players may function as laborers, selling each period's labor for ten credits (a unit of money) to the "bank" for a periodic salary. Alternatively, they may sell labor to other students, buy labor, use labor to create products, and generally function as entrepreneurs in search of higher profits. The game is structured so that combinations of labor may be used in a more efficient fashion to produce a greater quantity of products, so economic progress is achieved by buying labor, or otherwise organizing people into combinations that will yield greater productivity.

The purpose of all this is grounded in our earlier discussion of the need for students to understand the dynamics of free market economics. More specifically, Cannon, Yaprak, and Mokra (1999) identify the following objectives for what they hope students will come to understand and appreciate through playing the game (pp. 266-7):

- ❑ The process through which a society creates wealth.
- ❑ The trade-off between consumption and investment decisions.
- ❑ How economies of scale and the application of capital contribute to wealth.
- ❑ How development tends to be synergistic (a non-zero-sum game).
- ❑ The nature and importance of collaborative competition in a free market economy.
- ❑ The role of labor, capital, and entrepreneurial effort in economic development.

From a student's perspective, of course, the most salient purpose of the game for many students is not to learn anything, but to win. Students win by performing entrepreneurial tasks with excellence. This gives them credits (the "money" used in the game), or the things they can buy with these credits. Ultimately, they "win" by harvesting their investments in the form of satisfaction (the game's unit of consumer satisfaction) gained by actually consuming the output of the economic system to increase one's standard of living. Achieving the learning objectives listed above is a by-product of playing to "win."

### Microeconomic consequences

The microeconomic consequences of student decisions are profits resulting from the range of possible student decisions, from the simple sale of labor to the sophisticated entrepreneurial activities. To facilitate these activities, students have unlimited credit during any given period of play. That is they may borrow money to finance their business operations, providing that they pay off all their debts by the end of the period. Thus, they may buy labor or products from other students, purchase new machinery,

spend as much money as they like, as long as they can dispose of what they have purchased at a profit. If they fail to pay their debts, all their assets are forfeit, and they must begin the next period with nothing but their regular one unit of labor.

### Macroeconomic consequences

The macroeconomic consequences of the game are, as they are in real economies, a product of the combined microeconomic activities of the students. If every student decided to function as a laborer, simply taking a periodic wage, the economy would stagnate. However, the game is structured so that value may be created by combining labor, purchasing machinery, developing attractive product assortments, and generally conducting business activities that capitalize on the potential economies of scale built into the game. This value is available not only to the individuals who create it, but to other students as well, because of the increased demand and supply it creates for the whole economy.

### Player feedback

As we have noted, learning is a by-product of students playing the game to "win." They analyze the potential of the labor- and product-related alternatives facing them and plan, developing and implementing strategies to increase their wealth. The game is structured in such a way as to make the immediate consequences of a student's period-by-period activities obvious. However, the broader working of the economic system is less obvious, as it is in real life. In order to make these aspects of the game more obvious, students are provided with feedback, both on how they are performing, and on how their economy is performing in general. In the computer/Internet-based version we are proposing, this feedback would come in the form of a period report, including a number of key performance indices. These are shown in Table 1:

We will return to this performance report later, after we have discussed the variables that go into it. Note, however, three key indices. First is the index of economic performance. It provides an indication of how much value the player has been able to achieve, utilizing various forms of economic leverage (production economies, automation, etc.). Second, the figures in the average balance columns provide the average end-of-period balances for all students/teams, thus giving students a way of benchmarking their performance against that of other students. Third, and perhaps most important for teaching the role of economic activity in developing a higher standard of living, the index of economic well-being simulates the increased standard of living achieved through the entrepreneurial activities of the game.

Note that transaction log that follows the performance report. This is generated by the computer, based on the transactions that have been entered during the period (period 8, in this case). A player may call up this report any time during the period to see what has transpired so far,

TABLE 1: A sample period Performance Report for a student (team)

Period 8 performance report: katzpa			
<i>Performance Dimension</i>	<i>Used This Period</i>	<i>Ending balance</i>	<i>Average Balance for all players</i>
Labor	14	n/a	n/a
Credits	500	200	50
Machines	+2	6	3.5
Product A	+4	10	2.1
Product B	+4	10	2.8
Product C	+4	10	2.5
Product D	+2	6	3.1
Product E	+2	4	1.9
Sats	+158	378	63 <sup>3</sup>
Index of economic performance	46 <sup>1</sup>	n/a	24.3 <sup>2</sup>
Index of economic well-being	n/a	47.25	38.1

<sup>1</sup> An index of leverage, indicating the ratio of value created relative to the value of a single unit of labor

<sup>2</sup> The average index for all players in this period

<sup>3</sup> An index of the overall (cumulative) standard of living achieved through economic development

Transactions				Running Balances								
<i>Source</i>	<i>Item</i>	<i>Qty</i>	<i>Price</i>	<i>Credit</i>	<i>Labor</i>	<i>Mach</i>	<i>Products</i>					
							<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>Sats</i>
Bank	labor	5	0 cr	200	5	4	0	0	4	14	12	220
ladyjane	labor	1	40 cr	160	6	4	0	0	4	14	12	220
thumper	labor	1	40 cr	120	7	4	0	0	4	14	12	220
icequeen	labor	1	40 cr	80	8	4	0	0	4	14	12	220
banibley	labor	1	40 cr	40	9	4	0	0	4	14	12	220
jpdanger	labor	2	80 cr	(40)	11	4	0	0	4	14	12	220
cardinal	labor	3	120 cr	(160)	14	4	0	0	4	14	12	220
bank	product	56	14 la	(160)	0	4	20	20	20	14	12	220
bank	machine	2	300 cr	(460)	0	6	20	20	20	14	12	220
bank	product	(46)	460 cr	0	0	6	10	10	10	6	4	220
bank	sat	158	20 pr	0	0	6	6	6	6	0	0	378

monitoring such things as negative credit balances (due by the end of the period), labor and product availability.

Again, we will return to the derivation of these various performance indices as we discuss the inner workings of the game. However, the final element of player feedback is debriefing. (See Markulis and Strang 2003 for a conceptual review). Fritzche, Leonard, Boscia, and Anderson 2004 provide a concise and useful set of questions that can be adapted to the process). This provides a critical wrap-up to student learning. The performance indices provide wonderful grist for conducting debriefing activities. For instance, the instructor might go through the performance patterns of a player across time, and discuss what was really happening, and how it reflected in the indices. Prominent among these would be the discussion of economic development, how it improved standard of living, the trade-up between investment and consumption activities, and so forth.

## Motivation

Gentry (1990) argues that learning increases with involvement, and, presumably, involvement with motivation. While the original *Progress* game was highly engaging for students, when we analyze motivational factors, the Internet version appears to have even greater motivational potential. This follows from either of two schools of thought regarding motivation in simulation games and experiential learning – intrinsic and extrinsic.

Hodgett and Kreitner (1975) suggest that most of the work in simulating and experiential learning relies on intrinsic motivation. While this may be true, they offer no theory of how intrinsic motivation works. Gentry and Burns (Gentry and Burns 1996; Burns and Gentry 1998; Gentry, Burns, Putrevu, Hongyan, Williams, Bare, and Gentry 2001; Gentry, Burns, Dickenson, Putrevu, Chun, Hongyan, Williams, Bare, and Gentry 2002) suggest such a theory, drawing on the work of Loewenstein (1994). They argue that students have an intrinsic need to close the information gap between what they know and what they want to know.

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This will continue, as long as additional knowledge triggers a desire for still more understanding, and providing that the task does not become so overwhelming that students can't cope.

*Virtual Progress* appears to provide an environment where this is likely to happen. The game is basically very simple, so students are not overwhelmed (as they might be with more complex games). However, each new insight leads to expanding possibilities, thus creating the potential for on-going information gaps. While this is true of *Progress* as well, the efficiency of online administration reduces the chances of students becoming overwhelmed by the mechanics of game administration.

In response to their criticism of intrinsic motivation in games, Hodgetts and Kreitner (1975) propose an expectancy-value model to explain simulation motivation. According to their model, motivation depends on extrinsic rewards, delivered in the form of bonus points for positive performance. Based on this model, we would expect the *index of economic performance* and the *index of economic well-being* incorporated in *Virtual Progress* to provide a strong motivational influence on game participation.

Yakonich, Cannon, and Ternan (1997) argue that both intrinsic and extrinsic motivations are important. They draw on Lawler's (1971) in an effort to develop an expectancy-value model that integrates the two approaches. Among other things, their model supports the above conclusions. It also suggests that the nature of student motivation might vary by student. The diversity of student strategies possible in *Virtual Progress* accommodates the varying needs of students. For instance, if a student were to frame the game as a necessary means to an educational objectives, the performance indicators provide an ideal mechanism for giving the student the rewards (a good grade, resulting from high performance) she seeks from the game. For the more intrinsically oriented student, the creative aspects of the game provide a different kind of motivation.

### THE STRUCTURE OF THE GAME

The actual structure of the game is built around transactions involving labor, credits, machines, products and sats. The transaction system includes two key components. First is a Bulletin Board, whereby students can communicate. Second is a Contract.

FIGURE 2: A sample excerpt from a *Progress* Bulletin Board

<b>Discussion Topic:</b> I need labor!
<b>From:</b> bigdaddy
<b>Date:</b> Tue Feb 12, 2005, 11:06
I need to buy four units of labor. I can pay 20 credits each. First come, first serve. I gotta put this puppy to rest by Thursday, so I can wheel and deal before period end on Monday.
<b>Discussion Topic:</b> I need labor!
<b>From:</b> johnsonm
<b>Date:</b> Tue Feb 12, 2005, 13:01
What you been smoking, bigdaddy? I'll sell you my unit for 35, and we need to pull the trigger by 20:00 tonight!
<b>Discussion Topic:</b> I need labor!
<b>From:</b> bigdaddy
<b>Date:</b> Tue Feb 12, 2005, 18:12
Done, johnsonm! Hey, can't blame me for trying. I posted our Contract.
<b>Discussion Topic:</b> I need labor!
<b>From:</b> katzpa
<b>Date:</b> Tue Feb 12, 2005, 18:20
Hey, johnsonm. I'll take 35-credit action any time. But I'm a democratic kinda guy. How 'bout we do divvies. I figure four of us can pull out 160 credits. So, send me your tired and hungry laborers, and I'll pay 40. Let's put this thing to bed tonight!
<b>Discussion Topic:</b> I need labor!
<b>From:</b> ladyjane
<b>Date:</b> Tue Feb 12, 2005
Oooh! I love it when you talk like that. Count me in to sell a labor unit for 40 credits.

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Bulletin Board communications would typically consist of postings, with subsequent threads of responses much as we would expect to find on an Internet bulletin board. Figure 2 illustrates a section of such a board. Note that this serves as the primary means for market communications.

None of these bulletin board conversations have any official significance. All official transactions are processed through a Contract. The contract is an official document that tells the computer to actually process a transaction between two students/teams (See Figure 3).

Note that the Contract provides the primary interface between players and the game administrator. Aside from

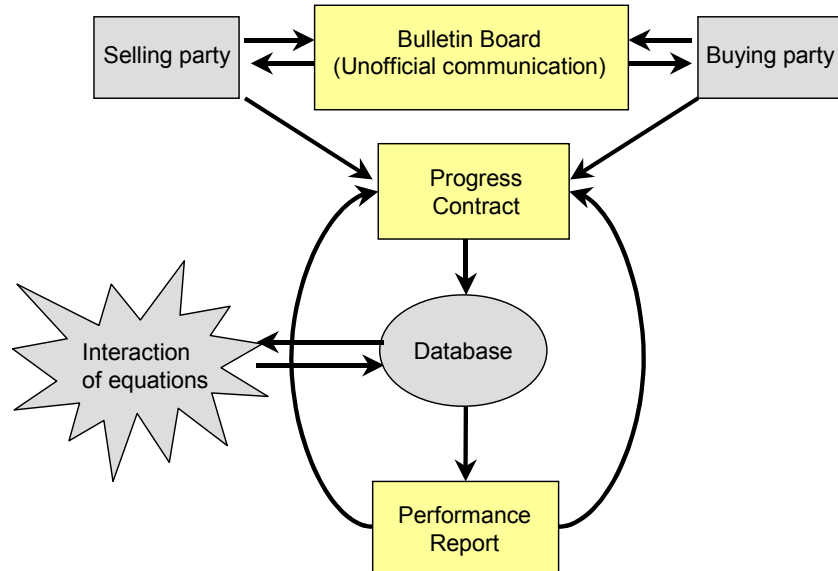
providing a mechanism for officially confirming the transfer of assets between players, it also provides a mechanism for carrying on transactions with the game administrator, such as selling back labor or products to the administrator (the “bank”), buying machines, authorizing production of products, and consuming products (e.g. buying sats). In addition, it provides a mechanism for the game administrator to deliver information regarding production costs, exchange rates for sats, and to order the Performance Report (illustrated in Table 1).

FIGURE 3: A sample *Progress Contract*

<b>Buying party:</b>	<input type="text" value="bigdaddy"/>	▼	<b>Selling party:</b>	<input type="text" value="johnsonm"/>	▼
<input type="button" value="Click here to authorize"/>			<input type="button" value="Click here to authorize"/>		
<b>Quantity</b>					
<b>Labor</b>	<input type="text" value="1"/>	▼			
<b>Machines</b>	<input type="text"/>	▼			
<b>Product A</b>	<input type="text"/>	▼			
<b>Product B</b>	<input type="text"/>	▼			
<b>Product C</b>	<input type="text"/>	▼			
<b>Product D</b>	<input type="text"/>	▼			
<b>Product E</b>	<input type="text"/>	▼			
<b>Total price:</b>	<input type="text" value="35 credits"/>	▼			
<b>Buy machines</b>	<input type="text"/>	▼	<b>Consume (buy sats)</b>	<input type="text"/>	▼
<b>Make products</b>	<input type="text"/>	▼	<b>Order information</b>	<input type="text"/>	▼
<input type="button" value="View performance report"/>					

Underlying the Contract, of course, the game includes a technical structure of programming, databases, and interactive components. These are illustrated in Figure 4.

Figure 4: The underlying technical structure of the game



### Credits

Credits are the units of money used in *Progress*. These are provided by the bank in two ways: First, students may obtain money from the bank by selling labor and/or products to the bank for their intrinsic worth of 10 credits per unit. Second, students may borrow any amount of credits from the bank they desire for the duration of a single period.

At the end of each period, students must repay their loans or go into bankruptcy (forfeiting all their accumulated assets -- credits, machinery, products, and sats, essentially starting the game over again). While a student may earn money through the clever buying and selling of labor and products, in the end, someone must extract money from the bank in order for students to pay off their loans. Typically, this will be done by selling back products for 10 credits each, as shown in the last transaction shown in Table 1. As we noted earlier, students/teams may request a Performance Report at any time to monitor balances and see what loans may be outstanding.

To borrow credits, a student merely spends them. For instance, if bigdaddy did not have 35 credits to pay johnsonm for the transaction specified in Figure 3, the bank would automatically extend a 35-credit loan. We can see how this works from the transaction log in Table 1, beginning with the jpdanger transaction.

### Sats

Sats are the game's measure of satisfaction and the ultimate measure of success for players of the game. In the structure of the game, sats are designed to highlight the trade-off between investment spending (to accumulate machines, credits, and products) versus consumption (sats). Players must invest in order to purchase sats, but the investments make no direct contribution to player's standard of living, and that of the simulated society as a whole.

In order to make the trade-off more compelling, we have added the aforementioned index of economic well-being ( $IW_{i,t}$ ) as a measure of the overall quality of life a player has been able to achieve over the course of the game. In real life, the major temptation is to maximize current satisfaction at the expense of capital investment. In the game, the temptation is just the opposite. All else being equal, players feel no pain associated with a low standard of living and would generally be content to save all spending on sats until the end of the game, when their resources are the greatest.

Cannon, Yaprak and Mokra (1999) address the problem of deferred spending on sats by capping the maximum number of sats players can buy in any given period. We rely on the index of well-being, including a smoothing factor that rewards consistent contributions to sats throughout the game. The formula is:

$$IW_{i,t} = a \cdot S_{i,t} + (1 - a) \cdot S_{i,t-1} \quad (1)$$

where

$IW_{i,t}$  = index of well-being for period  $t$  for player  $i$

$A$  = smoothing factor, indicating the relative importance of current versus past satisfaction (recommended .25)

$S_{i,t}$  = satisfaction earned by player  $i$  in time  $t$

We will introduce the actual method for computing sats ( $S_{i,t}$ ) in a later section, in which we discuss how products are created and consumed. Note, however, that the recommended smoothing factor ( $a$ ) is three-quarters of the weight on past satisfaction (representing the metaphoric fact that a single period of good living does not erase the pain of prior starvation).

As it turns out, players will discover that investment early in the game is so important that "starving" might still

be a good strategy. However, here, as in life, it does not come without its cost.

## Labor

Labor is the most fundamental unit of the game. Like products, labor also has an intrinsic value of 10 credits per unit. However, labor tends to be in short supply. Given its essential role in production, its value will typically be driven up by supply and demand. As we saw in the discussion shown in Figure 2, combining four units of labor will produce 16 units of product, the value of which is also 10 credits each. This would tend to drive bidding up to 40 credits per unit of labor.

Labor cannot be carried over from period to another. However, within a period, it can be bought and sold. So, if bigdaddy were able to buy a unit of labor from johnsonm for 35 credits, he could resell it to katzpa for 40 credits as soon as johnsonm signed the Contract.

Note the owning a machine provides an additional unit of labor every period. To illustrate, katzpa's first transaction shown in Table 1 is to receive 5 units of labor from the bank (the game administrator). One of these is the result of being a player in the game. The other four result from owning four machines.

## Machines

As we have just seen, machines increase productivity by providing an additional unit of labor per machine every period. Given the critical nature of labor in the game, machines are valuable indeed. Cannon, Yaprak and Mokra (1999) suggest a price of 150 credits. This seems appropriate for games with a relatively high number of periods. However, accumulating enough capital to purchase the first few machines takes a relatively long time. This is because the machine cannot be utilized until the period following its purchase. Machines must be paid for without the benefit of the added production the machines will bring. For shorter games (ten periods or less), we recommend a lower price, perhaps \$100.

Having said this, we should note that one way to purchase machines is to sell shares to other players. This would involve collecting money from them in return for a promise of future income (i.e. transferring money using the Contract shown in Figure 3, but without specifying labor, machines, or products). Depending on the relative emphasis game designers want to put on cooperation, they might choose to raise the cost of machinery (putting more emphasis on cooperation) or reduce it (putting relatively less emphasis on cooperation and more on the importance of capital investment in economic growth).

Cannon, Yaprak and Mokra (1999) conceptualized machines as labor enhancers, not labor substitutes. A machine could double the effective value of one unit of labor, but in the absence of this unit, the machine would have no value. In our conception of the game, a machine is the equivalent of one unit of labor. While this is a minor adjustment in most circumstances, having two kinds of

labor created unnecessary ambiguities in the game. For instance, if machines are a labor enhancer, can labor created by a machine be matched with another machine to double the machine's productivity? And what if a unit of machine labor is sold? Must the buyers bear in mind that they are purchasing different kinds of labor? If so, what is the purpose? Maintaining two kinds of labor complicates the game substantially, with minimal payoff.

## Products

*Progress* features five different basic types of products, designated *A, B, C, D* and *E*, or what we will refer to as  $P_1$  through  $P_n$ . We believe the general notation is superior, because there is no reason that there could not be more or fewer products ( $n$ ). Typically, the larger the number of players in the game, the larger the number of products should be. We recommend five products for games with up to 20-30 students. By using teams as players, the actual number of students could be even more. However, teams should be kept small in order to minimize the difficulty in discussing decisions when the work is being done online, and the students are not meeting in person.

Products have two types of value. First, they can be exchanged for credits (sold to the "bank") in return for their intrinsic value of ten credits per product, thus creating money (credits). Second, they can be combined into relatively more exotic combination products and exchanged for sats.

## Creating money.

Recall that players can borrow money as needed within a given period to finance the cash flow requirements of their operations. However, at the end of the period, they must pay off these loans. This can involve relatively large sums, as we saw in the transactions shown in Table 1.

Consistent with the 10-credit intrinsic value of basic products, a product can be created by consuming a unit of labor. However, as more labor is applied, the game evokes economies of scale and produces an increasing number of products per unit of labor. In Cannon, Yaprak and Mokra (1999) conception of the game, they provide a chart indicating increasing returns (economies of scale) as more labor is applied, up to a level of four units of labor. These are followed by diminishing returns as more labor is applied above five units.

In our conception, we suggest a formula for determining the number of products produced in return for increasing quantities of labor:

$$P_{i,j} = INT \left( \sum_{k=1}^N (b \cdot k - c \cdot \max\{0, k - M\}) \right) \quad (2)$$

$$N = \max \left\{ L, \frac{c \cdot M}{b - c} \right\} \quad (3)$$

where

$P_{i,j}$  = the amount of product type  $j$  produced by player



$i$  in a given period

- $L$  = the amount of labor allocated to production of  $P_i$  in a given period
- $N$  = the effective amount of labor allocated to production  $P_i$  in a given period, recognizing the point at which diminishing returns cause additional labor to become ineffective
- $B$  = a parameter determining the increase in economies of scale in response to additional amounts of labor (1.0 recommended)
- $C$  = a parameter determining the decrease in economies of scale in response to additional amounts of labor beyond the point of diminishing returns (2.0 recommended)
- $M$  = the “inflection point,” where additional amounts of labor shift from increasing to diminishing returns (10 recommended)
- $K$  = an index variable used to represent different levels of labor input

While Equation (1) does not reproduce the exact labor-production relationship as those given in Cannon, Yaprak, and Mokra (1999), it yields similar results with parameters set at  $b=1.8$ ,  $c=3.3$ , and  $M=4$ . We recommend the values of  $b=1.0$ ,  $c=2.0$ , and  $M=10$ , as suggested above. This provides for greater economies of scale, thus encouraging greater specialization by players in their production activities. The specialization, in turn, creates a greater incentive for trade, and ultimately, variety in entrepreneurial activities later in the game.

The change from a table to an equation for converting labor input to product output facilitates the transformation of the game to a computer-mediated format. Even more important, an equation provides much greater flexibility in adjusting the basic parameters of the game.

### Creating sats with combination products.

Combination products consist of different combinations of  $P_j$ . For instance,  $P_1^1 P_2^2 P_3^3$  would be a combination product consisting of 1 unit of product  $P_1$ , 2 units of product  $P_2$ , and 3 units of product  $P_3$ . Consuming these products is how players acquire sats. Cannon, Yaprak, and Mokra (1999) provide charts to determine the value of each combination. In order to provide more flexibility and to facilitate programming, we suggest the formula provided in Equation (4). It provides roughly equivalent results, but it provides the flexibility needed to accommodate changes in the number of products available.

$$S = \left( \sum_{j=1}^n \left( d \cdot e^j \cdot P_j^{n_j} \right) \right) \quad (4)$$

$$P_j^{n_j} = \sum_k^{n_j} \frac{10}{k} \quad (5)$$

where

- $P_j^{n_j}$  = the value of a combination product consisting of  $n_j$  units of product  $P_j$ . (Note that in cases where  $n_j$  is 0, no summation takes place, and the value of  $P_j^{n_j}$  is 0)
- $S$  = the number of sats resulting from consumption of a combination product consisting of a set of  $n$  amount of labor allocated to production of  $P_j$  in a given period
- $N$  = the number of basic products available in the game
- $D$  = a parameter representing the synergistic effects of combining more than one type of basic product into the combination product (2.5 recommended)
- $E$  = a parameter determining the diminishing returns (0.5 recommended)
- $K$  = a index variable representing each of the several units of a given product being combined

### Adventures in new-product development.

In contrast to the original *Progress* game, where players had a limit to how many sats they could accumulate in a given period, in *Virtual Progress* players may accumulate as many as they wish. We have justified this change by using a smoothing function (Equation 1) as a way to reward players for acquiring sats on an on-going basis. However, placing no limits on how many products can be consumed to accumulate sats has a major advantage for game dynamics. The only constraint on the consumption of products is that a player may not consume the same product twice. This limitation only applies within the boundaries of a single team. Thus, the consumption of a product by Team A does not deny Team B the chance to consumer the same product. The one-time consumption rule creates a tremendous impetus for developing new products.

New products are not complicated. They are simply combinations of different number of basic products, as suggested in Equations (4) and (5). Their creation and management, however, is complicated by two factors: First, the value is not obvious to the players. They may enter a product configuration by evoking a subroutine attached to the “buy sats” function box in Figure 3. The routine will evaluate the configuration, tell the player whether it is “legal” (possible, given the available basic products in inventory and acceptable, given the provision that the same configuration may not be consumed twice by the same

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player). Second, players must have the basic products in inventory that are needed to service a particular product configuration.

The difficulties involved in developing and consuming new products creates a host of opportunities for entrepreneurial activities on the part of game players. The most obvious is for players to set themselves up as “retailers,” buying basic products in bulk (in return for a discount, justified by the lower effort required by “manufacturers” to dispose of their products), and offering to sell finished products.

A less obvious opportunity is for players to set up “service” industries. Students are constrained by time and their ability to gather and digest the information they need to play the game well. A service provider might specialize in developing sat packages – determining what products are “legal” for a given client, where they might be obtained, and how much they cost. A more sophisticated provider might even provide advisory services, suggesting how much to consumer versus invest, what kind of investments to make, and so forth. Someone might even provide actual investment opportunities, such as brokerage services or venture capital funds. A player might post a notice on the Bulletin Board to the effect of, “Tired of trying to figure out where to invest your credits? I am putting together an investment fund for which I will do the research, and all you have to do is invest your credits and share in the profits.”

The proliferation of products and services will quickly make the Bulletin Board potentially very cluttered and hard to manage. This creates yet another avenue for entrepreneurial activity. We might actually see advertising agencies, sales representatives, and so forth. All of these are possible within the basic *Virtual Progress* environment.

### SUMMARY AND CONCLUSIONS

The premise of both the *Progress* game and *Virtual Progress*, as described in this paper, is that the basic principles of economic development are relatively simple. The activities designed to exploit these principles are both manifold and complex. As a result, students often get caught up in the details and fail to see the big picture. *Progress* seeks to create a world in which the basic economic principles operate in all their simplicity. Students, then, as players of the game, can see how economic activity happens through their own entrepreneurial activities.

In this paper, we have suggested that *Virtual Progress* provides a much better laboratory for playing the game. By using the connectedness available through the Internet, a class can proceed with its usual lectures and discussions, while *Virtual Progress* works in the background. The specific benefits can be evaluated in terms of the objectives established for the original *Progress* game:

- ❑ *Understanding the process through which a society creates wealth.* Not only will players experience this through playing the game, but, with *Virtual Progress*, they will get specific feedback in the

form of an *index of economic performance* and an index of *economic well-being*. These provide a tangible measure of productivity and an indication of how economic activity has increased standard of living.

- ❑ *Understanding the trade-off between consumption and investment decisions.* The *index of economic well-being* puts a very high weight on continuing consumption activities. At the same time, players quickly learn that they must invest heavily if they are to progress. This tension mirrors the corresponding tension between consumption and investment in real life situations.
- ❑ *How economies of scale and the application of capital contribute to wealth.* The central economic activity in the game – production of products – is strongly driven by the availability and the need for economies of scale. The effect these have is most directly apparent in the *index of economic performance*.
- ❑ *How development tends to be synergistic (a non-zero-sum game).* One of the lessons quickly learned in the marketplace of both *Progress* and *Virtual Progress* is that economically disadvantaged players make poor customers. This is especially apparent in later stages of the game, when the opportunity for developing innovative products and services is greatest. *Virtual Progress* lends itself to much more sophisticated new-product development, and hence, more learning with respect to this objective.
- ❑ *The nature and importance of collaborative competition in a free market economy.* One of the most important points in the development of the game is when students begin to realize that they will gain more from cooperating than competing. For instance, machines are both valuable and hard to purchase. They can be purchased relatively early in the game if students band together to buy them, even if they will end up competing with each other to sell the combined products that are possible when lower-priced basic products become available on the market.
- ❑ *The role of labor, capital, and entrepreneurial effort in economic development.* The interaction of labor, capital, and entrepreneurial effort are all central features of the game. One of the key roles of the debriefing process is to help students grasp the significance of what they have just experienced as players in the game. The difference between this and other approaches is that the discussion draws on real phenomena that the students have just experienced. Again, *Virtual Progress* offers much greater potential because of the richer business environment.

As a final note, we should comment on the flexibility of *Progress* for customizing it to address additional teaching

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objectives. For instance, Cannon, Yaprak, Mokra, and Miller (2000) discussed how the game could be adapted to address the effects of governmental policy. In this paper, we mentioned the potential for addressing the importance of contract law. These are areas that merit further exploration, particularly drawing on the added capabilities of computer management and delivery by means of the Internet. The fact that administering the game online enables the administrator to include players from more than a single location, including players from different countries, provides enormous potential for exploring differences in cross-cultural and political orientation.

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