Disclaimer: The commentary and modeling techniques shared in this user manual do not necessarily reflect those from EWU's Office of Institutional Research, Academic Affairs Planning and Budget, and the Division of Business and Strategy.

PAMCAM User Manual

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1. Introduction

Based upon both pedagogical and financial considerations, PAMCAM (Personnel Allocation Model Contribution Margin Assessment Model) is a free, open resource mathematical model designed to inform decision-making related to the management of faculty personnel and corresponding credit-bearing academic activity centers in higher education. The operations of instruction delivery associated with an academic activity center vary along a continuum spanning from a single course section to the entire university academic portfolio. PAMCAM brings forth no new ideas from a mathematics or finance standpoint. Furthermore, the nature of PAMCAM analysis has been routinely performed at universities since the 1990's with variations in terminology, emphasis areas, depth, and breadth of analysis. What appears to be novel for PAMCAM, however, is 1) how the change in contribution margin is disaggregated into two parts that elucidate the separate effects of enrollment growth and student-faculty ratio change, and 2) how information is graphically communicated using a four-sided design envelope that captures key considerations commonly made amid discussions around personnel and academic activity center management. These differences introduce fertile ground for faculty and administrators to more effectively communicate their perspective and understand others' perspectives using a common vocabulary with a clearly understood definition of terms.

The evaluation process around faculty personnel and academic program decision-making should feature transparency, clarity, adequate time for absorption of information, and data-informed rationale. PAMCAM is useful for establishing a foundation for such a process. The motivation for the use of PAMCAM, therefore, is to help advance a healthy shared governance environment as faculty personnel and academic activity center decisions are made.

2. Activity Centers

Within the context of PAMCAM analysis, the contribution margin captures the difference between an academic activity center's revenue and expenses associated with customers and employees, respectively. Customers may be primarily envisioned collectively as students and prospective employers for whom they wish to work.

Employees are the faculty whose services are curriculum delivery and peripheral supporting engagement. As such, the apparatus supporting direct operations of instruction delivery associated with a single course section, discipline area, degree-major, academic program, department, school, college, or university may comprise an academic activity center.

PAMCAM was first introduced (Smith, et al., 2022) in the form of a relatively complex-looking model, and later presented in a more succinct and understandable model format (Smith, 2025); elements of the later article are summarized herein. As explained in both articles, the PAMCAM contribution margin does not account for fixed (or nearly fixed) costs. Such fixed costs include but are not limited to those related to support staff, custodial services, landscaping, police, property insurance, and utilities. These costs are insensitive to relatively small changes in enrollment and student faculty ratio. Because the change in contribution margin due to a change in enrollment or change in student-faculty ratio is a central mathematical pillar for PAMCAM, such fixed costs are ignored. The contribution margin for an academic activity center, therefore, should almost always be equal to or greater than zero. They are considered profit centers in support of other activities within an encompassing, non-profit academic enterprise. A culture in which discussions around change in contribution margin are integrated into strategic planning and execution helps establish a strong and inclusive foundation for teamwork, entrepreneurship, creativity, and a competitive advantage for an institution of higher education.

3. Contribution Margin

The contribution margin for PAMCAM is expressed in (1) below. Students and faculty are defined in terms of full-time student equivalents (FTES) and full-time faculty equivalents (FTEF), respectively.

$$m = \left(t + a \cdot f - \frac{s}{R}\right) \cdot n \qquad (1)$$

where:

m is the annual contribution margin ($)

t is the weighted avg annual tuition per student ($/FTES)

a is the weighted avg annual credit hours per student (SCH/ FTES)

f is the weighted avg annual state formula funding per credit hour ($/SCH)
s is the weighted avg annual salary per faculty ($/FTEF)
R is the annualized student-faculty ratio (FTES/FTEF)
n is the annualized enrollment (FTES)

4. Design Envelope

In Figure 1, the previous, current, and projected states of an academic activity center are denoted by points 1, 2, and 3, respectively. The PAMCAM design envelope may be envisioned as the permissible space in which an academic activity center may reside. It is bound by four lines, as illustrated in Figure 1. The slope of the lower line (Line A) is determined by constraining (1) to be equal to or greater than zero, then solving for R. This lower line represents the financial break-even boundary below which the contribution margin is negative. Therefore, an academic activity center located above this lower line is profitable; this lower boundary is a financial constraint. The slope of the upper line (Line B) is the student-faculty ratio above which pedagogical quality is unacceptably low; this upper boundary is a pedagogical constraint typically proposed by a faculty program coordinator and subject to approval by a dean, director, and/or department chair. The placement of the left-hand and right-hand boundaries are prescribed, based upon functional and aspirational/space considerations, respectively.

5. Change in Faculty

PAMCAM yields the change in faculty, dp, required to move the center to a position along the top boundary of the design envelope; this is at the intersection of Line B and C in Figure 1. As such, dp is calculated according to the following relationship.

$$dp = \frac{n_{final}}{R_{max}} - p_{initial} \quad (2)$$

where:
n_{final} is the final FTES coordinate
R_{max} is the slope of the line coincident with the top line of the design envelope
$p_{initial}$ is the initial FTEF coordinate

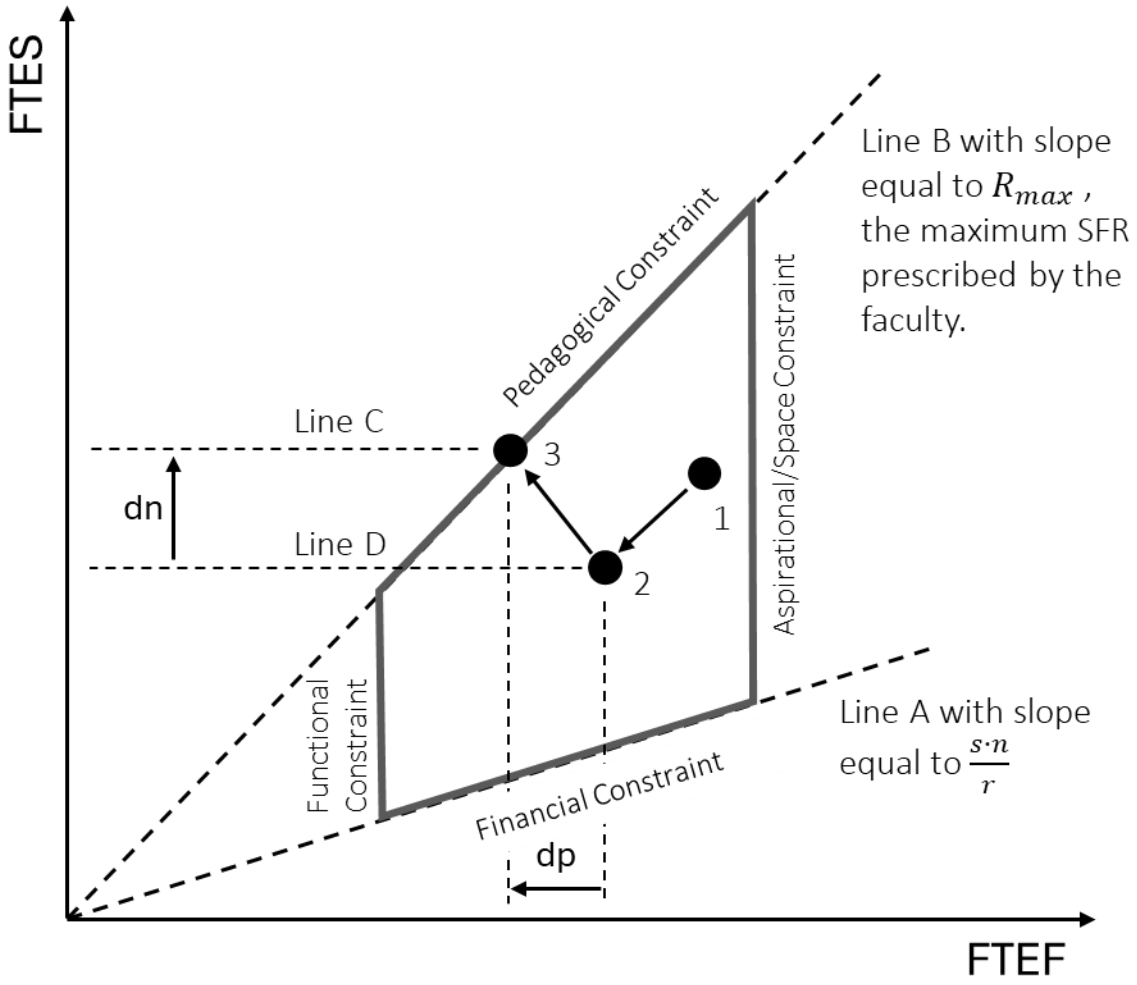


Figure 1 Design Envelope

6. Change in Contribution Margin

Any state (ie. location) within the PAMCAM design envelope is satisfactory from a financial perspective. The optimum financial state, however, is at the projected Point 3 in Figure 1; this state corresponds to maximum financial efficiency under the prescribed conditions. Therefore, the PAMCAM model is designed to conform to a principle of maximum financial efficiency. Anywhere within the design envelope or along its boundaries is pedagogically permissible. The optimum location, therefore, in the PAMCAM design envelope is along the top boundary at which both the principle of maximum financial efficiency and pedagogical-based constraints are satisfied.

A change in enrollment, dn, and/or a change in student-faculty ratio, dR, leads to movement of the academic activity center's state from Point 2 to Point 3 which in turn leads to a change in its contribution margin. While motion from Point 2 to 3 for some academic activity centers will feature a positive contribution margin, others will feature a negative contribution margin. Decision-makers within the college should manage this dynamic by reallocating financial resources strategically.

With the understanding that everyone on campus plays a role in enrollment management, the impact of an individual's decision-making on enrollment is not always clear because there exists a myriad of internal and external factors that also influence enrollment. Thus, the dean, director, and chair's connection to the dn "lever" is mostly reactive. The dR lever is fundamentally different. It can more easily be controlled through intentional actions within a college. Adding an additional lecturer or not backfilling a recently vacated tenured position will affect dR. Thus, the dean, director, and chair's connection to the dR "lever" is mostly proactive. It follows, therefore, that a manager would find useful a deeper understanding of the difference between the impact of their reactive and proactive decision-making has on academic activity center contribution margins in their college. The PAMCAM model quantitatively shows this difference both numerically and graphically.

Let the change in m, R, and n be denoted by $dm, dR,$ and dn, respectively. From (1), it is seen that m is nonlinear with respect to R. Also, the impact of n is dependent upon R; there is an interaction between the two. An efficient way to accurately separate the portion of dm due to dR from the portion of dm due to dn is to employ an approximation model involving a Taylor series expansion described within the field of differential calculus (Weir, et al., 2015). For this current PAMCAM model, a tenth order Taylor series expansion model is introduced in (3) for the change in contribution margin, dm, as a function of a change in enrollment, dn, and a change in student-faculty ratio, dR.

$$dm \approx \sum_{i=1}^{k} \frac{1}{i!} \cdot \frac{\partial^i}{\partial^i n} [m(n_o, R_o)] \cdot (dn)^i \; + \sum_{i=1}^{k} \frac{1}{i!} \cdot \frac{\partial^i}{\partial^i R} [m(n_o, R_o)] \cdot (dR)^i \qquad (3a)$$

or, because m is linear with respect to n,

$$dm \approx \frac{\partial}{\partial n}[m(n_o, R_o)] \cdot (dn) \; + \sum_{i=1}^{k} \frac{1}{i!} \cdot \frac{\partial^i}{\partial^i R}[m(n_o, R_o)] \cdot (dR)^i \qquad (3b)$$

where:

k = 10

n_o is the current year's enrollment
R_o is the current year's student-faculty ratio
dR is the change in student-faculty ratio from the current year to the next year

7. Graphical User Interface

PAMCAM may be built on various platforms and presented in graphical and/or numerical formats. Examples of suitable platforms are spreadsheets, web-based applications, and mobile phone applications. The current version is available in EXCEL. Because it has a built-in macro, it has an "xlsm" extension. The EXCEL model features five tabs: Sandbox, College 1, College, 2, College 3, College 4, and Division. Within the sandbox, users may engage in experimental analysis without affecting any other tab. Information in the college tabs, however, rolls into the division tab. Provided they are correctly coupled to the division tab, the four college tabs could be replaced with tabs for any number of colleges, departments, academic programs, or discipline areas. A web-based Sandbox as well as the EXCEL model are available at the free, open resource website at ……. (under construction).

Navigating the PAMCAM user interface is relatively simple, provided one understands the meaning of the input data and has access to reliable data. A user's understanding of the mathematical formulation shown in (3) is not essential to their effective use of PAMCAM. The following steps are recommended as an introductory process:

A. Activity Center: Decide on the type of academic activity center to be evaluated, in consultation with the office of institutional research, the division budget office, stakeholders within the college and the provost's office (hereafter called "stakeholders"). Unless there exists a compelling reason to do otherwise, the academic activity center analysis should begin at the discipline area level.

Results based upon PAMCAM analysis for discipline areas will roll into, for example, departments, colleges, and the division for subsequent PAMCAM analysis. This process is illustrated in the next section.

B. Students and Faculty: Decide on how FTES and FTEF are to be calculated in consultation with stakeholders. To account for service effects, FTES calculations should be based upon credit hours associated with any student in the classroom, regardless of their major, unless there exists a compelling reason to do otherwise. FTEF calculations should be based upon those instructors who teach students seated in the classroom, regardless of the instructor's home department. For the purposes of PAMCAM analysis, these instructors are affiliated with the department that manages the discipline area. These approaches are not necessary, but they are recommended. The key is consistency across analysis among stakeholders throughout the division.
C. Basic Input: Input estimated values for t, a, f, s, n, and p in the maroon-highlighted fields. Also input a value for the projected percent enrollment change from state 2 to 3; this is used to determine dn from state 2 to 3. Do not invest an unnecessary amount of time quibbling over the exact values. There will never be universal consensus on exact numbers. Noting that PAMCAM provides estimated values, stakeholders should consult with each other, agree on an estimate, then move on.
D. Strategic Input: This refers primarily to specification of the maximum student faculty ratio, R_{max}, which defines the top line of the design envelope. Prescription of R_{max} for state 3 allows for the calculation of dR from state 2 to 3. In addition to dn, the value for R_{max} will have a major impact on PAMCAM's recommended change in faculty, dp.
E. Adjusting the Graphs: Both graphs (as well as various cells) will automatically change, based upon changes to the input fields. The design envelope and/or arrows depicting changes in state may vanish from the space in the graphs. To reset graph layout, hit "control-q". If there is a desire to establish one's own custom scale on the graphs, they may double-click on the axes to make changes per the standard EXCEL process.
F. Sharing Results: To share PAMCAM results, hit "Control-p" to print out a one-page hardcopy or pdf.

8. Fictitious Illustrative Case Study

As part of a division-level action plan, the dean of College A tasks the chair of Department A1 to assess their faculty hiring needs for their department. The department chair, in turn, reaches out to the program coordinators for collection of data to help support a recommendation. Working with the office of institutional research, the program coordinators populate rows one through twenty-six in Table 1 with data for five discipline areas (with nonsensical names): Candles, Origami, Balloons, Presents, and Games. All five discipline areas apply to undergraduate-level course work for which 15 credit hours per term are considered full-time for students. The university academic year encompasses four terms: Fall, Winter, Spring, and Summer.

For the CAND 100 courses delivered in the fall, shown in row 2, there is a headcount (HC) of 77 students. Since CAND 100 is a 3-credit course, each student seated in the classroom represents 3/15 FTES. The total number of FTES, therefore, is 77 x (3/15) or 15.40. Alternatively, the 15.40 FTES could have been calculated by determining the total number of credit hours (231), then dividing 231 by 15.

Courses shown in Table 1 are taught by various combinations of part-time faculty (ie. adjunct), lecturers, tenure-track faculty, visiting scholars, and graduate students. The seventy-seven students in CAND 100 for the fall are taught in four sections, two each by an adjunct faculty, and two each by a tenure-track faculty resulting in a total FTEF of 0.8 The resulting SFR is 19.25 for the current year. For the previous year, a similar analysis is carried out leading to a total of 14.80 FTES and 0.65 FTEF for fall CAND 100. Continuing to work closely with the office of institutional research, the program coordinators prescribed a projected growth in FTES of 7.80% for the projected (next) year for fall CAND 100. Similar analysis was performed for the winter, spring, and summer terms for Candles leading to the roll-up shown in row 6.

The 7.28% projected growth rate is determined by computing the weighted average of the individual course %FTES values using their total SCH's for weights. Working closely with fellow faculty and in consultation with the department chair, the program coordinators prescribe a maximum SFR of 18; this value is based upon carefully weighed pedagogical considerations. The program coordinator notes that 1) the

current 18.67 SFR exceeds the maximum 18.00 SFR, and 2) the demand for Candles is projected to grow at a strong rate of 7.28%.

The following estimates were made by the program coordinators, in consultation with the office of institutional research and other stakeholders, for the current year for Candles:

- Average annual tuition per FTES, t: $8,000/FTES
- Average annual SCH per FTES, a: 32 SCH/FTES
- Average annual state support per SCH: $100/SCH
- Average annual salary/benefits per FTEF: $90,000/FTEF

These values were used for all analysis in this illustrative section. In practice however, some or all of them would vary across discipline areas.

PAMCAM results for Candles are shown in Figure 2. In conjunction with market demand data, space requirements, and other considerations, the coordinator discusses the PAMCAM results with the department chair and others in the department and college. The two arrows depict Candle's change in state from previous-to-current and from current-to-projected. Candles currently "lives" outside of (above) the permissible design envelope, as shown by the head of the first arrow. The PAMCAM model indicates an increase of 0.34 FTEF is needed to place Candles at its optimal location along the top boundary of the design envelope.

The values shown in the center-highlighted cell within the two heat maps at the bottom of the PAMCAM results page automatically correspond approximately to PAMCAM's recommended change to SFR (-3.57% or -0.67), the prescribed change in enrollment (7.28% or 4.08) and PAMCAM's recommended change to faculty (11.25% or 0.34). These heat maps provide additional quick-reference PAMCAM solutions without having to experiment with various combinations of input. After consideration of these heat maps and further consultation with stakeholders, the coordinator recommends hiring the 0.34 additional FTEF.

The contribution margin for Candles is $357,400 for the previous state (Year 1). Both FTES and FTEF grow when moving from previous state (Year 1) to the current state (Year 2). This results in a contribution margin of $357,200 for the current state. Even

with a 0.34 FTEF increase, the contribution margin grows further to $372,476. The right-hand graph in Figure 3 graphically shows the trend.

When moving from the current to projected state (ie. from Year 2 to Year 3), the total change in contribution margin is $15,276, despite a 0.67 decrease in SFR at a cost of $10,000 for an additional 0.34 FTEF. Candles is a growing profit center that the program coordinator considers worthy of strong consideration of a $10,000 investment in FTEF. (In practice, the actual increase in FTEF would have likely been a multiple of 0.05, say 0.25 or 0.40, due to how the workloads are calculated.)

Other program coordinators proceed with similar analysis for the other four discipline areas. As shown in Figure 3, Origami is trending in an unfavorable way. Its financial contribution to the university is $27,724 less for the current year than it was for the previous year. Yet, it still contributes to the university $94,776 for the current year. To rectify Origami's unfavorable trend, the coordinator considers PAMCAM's solution which would lead to an additional $12,619 in funding for the university, which in turn would lead to Origami delivering to the university $107,395 annually. This would require a reduction of 0.29 Origami FTEF. When shown these results, the department chair contemplates asking the dean to advocate for a portion of the $12,619 from Origami to help pay for the additional Candles FTEF.

PAMCAM results for Balloons suggest a need to reduce the number of FTEF by 0.74 thereby liberating $85,122 in funds to be invested elsewhere as shown in Figure 4. Presents is in trouble, as shown in Figure 5; it currently operates at an approximate break-even state while its headcount is at ten or less for all four terms. It is taught, however, by an adjunct faculty who has support from the coordinator who insists the course is an essential part of the curriculum. PAMCAM shows a required 0.22 reduction in FTEF, leading to the likelihood of collapsing the current set of sections into a set of fewer sections. Proactively, the coordinator consults with the academic advisor and department chair to mitigate possible roadblocks for students' efficient progress toward graduation.

Figure 6 shows a healthy trend for Games, leading to a required 0.04 increase in FTEF; again, due to how workloads are calculated, this small value would likely be interpreted as zero. PAMCAM results for the Department A1 roll-up are shown in

Figure 7. The maximum SFR of 18.06 (row 29 in Table 1) was not prescribed arbitrarily. It had to satisfy the following constraint:

$$m_{3,roll} - m_{2,roll} = \sum_{i=1}^{z} dm_i \quad (4a)$$

where: m_3 and m_2 are the contribution margin for projected and current states, respectively, for the roll-up center
"roll" denotes roll-up center (in this case, it is Department A)
z = # units rolled into the roll-up center (in this case, it is 5)
$dm_1, dm_2, dm_3, dm_4, dm_5$ are the change in contribution margins for the centers being rolled into the roll-up center. (In this case, they are Candles, Origami, Balloons, Presents, and Games.)
$\sum_{i=1}^{z} dm_i$ is determined to be $162,459 from Figures 3- 7.

Application of (1) to (4a), then solving for R_3 leads to:

$$R_3 = \frac{s \cdot n_3}{(t + a \cdot f) \cdot n_3 - \sum_{i=1}^{z} dm_i - \left(t + a \cdot f - \frac{s}{R_2}\right) \cdot n_2} \quad (4b)$$

For Department A1, the maximum SFR (ie. R_3) is calculated to be 18.06.

The department chair examines the PAMCAM results shown in Figure 7, noting that the 0.91 FTEF net decrease leads to a department contribution margin change in the amount of $162,459. Similar analysis is carried out for the other departments, colleges, and the division leading to results shown in Figures 8 – 14.

As shown in Figure 10, the dean of College A will introduce a contribution margin change of $235,450. First, and without considering the use of this $235,450, the dean redistributes funding within the college, noting the differences in contribution margin changes across the departments; these transactions would be for the following academic year. Second, if the dean provides sufficient justification (or pursuant to an RCM-type budget model), the dean may have access to a portion of the $235,450 for strategic investment into college-related initiatives. The chairs exercise a similar option within their departments.

While College A shows a projected positive contribution margin change of a (surplus) $235,450, Colleges B, C, and D show projections of a deficit of $220,012, surplus $1,016,103, and deficit $800,724, respectively. The resulting division roll-up leads to a projected contribution margin change of a surplus $230,818. The provost also considers redistribution across various areas within the division, based upon consultation with various stakeholders and/or pursuant to an RCM-type of budget model which rewards performance – all in harmony with the president's vision for the university.

References

Smith, L. M., Hall, K., Johnston, J., Noe, K., Hubbard, K., Beverly, L., & Guidry, M. (2022). A Systems Approach to Personnel Allocation Modeling in Higher Education. *www. aaua. org*, 85.

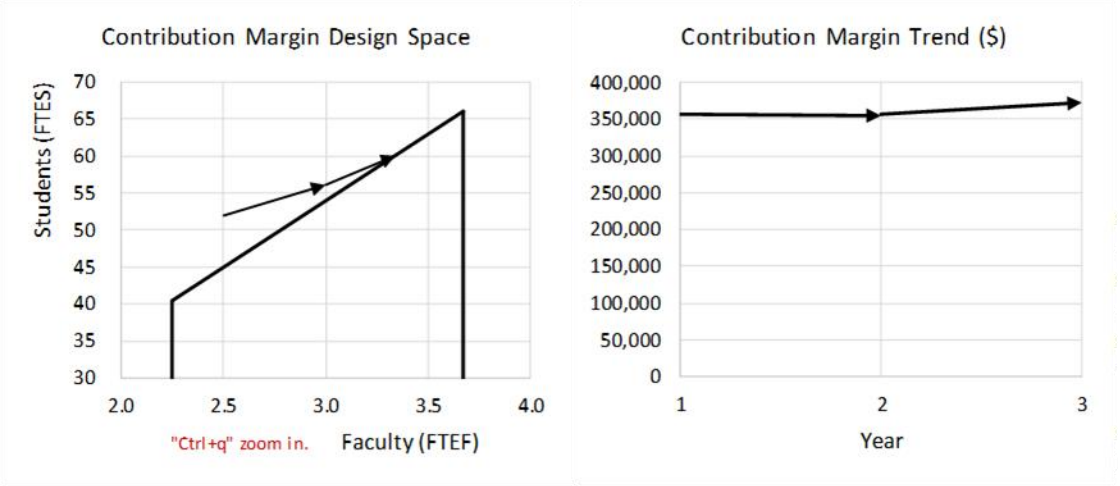
Smith, L. M. (2025). In Review. Contextualizing the Change in Contribution Margin of the Academic Program Portfolio within the University Operating Budget. Journal of Higher Education Management, XX. (I never found the time this past summer to re-submit the manuscript with revisions. So, I withdrew it from consideration.)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
	Discipline Area Roll-Ups for Dept A1 within College A													
				Current Year						Previous Year		Projected Year		
1	Disc.	Course	Terms	Crs SCH	HC	Tot SCH	FTES	FTEF	SFR	FTES	FTEF	%FTES	CM 2→3	Max. SFR
2	Candles	CAND 100	Fall	3	77	231	15.40	0.80	19.25	14.80	0.65	7.80%	2,447	18
3	Candles	CAND 240	Winter	3	80.5	241.5	16.10	0.75	21.47	13.20	0.80	6.80%	(6,212)	18
4	Candles	CAND 100	Spring	3	77.5	232.5	15.50	0.80	19.38	16.00	0.65	7.19%	3,004	18
5	Candles	CAND 400	Smr	3	45	135	9.00	0.65	13.85	8.00	0.40	7.40%	17,629	18
6	**Candles Discipline Area Roll-Up**						**56.00**	**3.00**	**18.67**	**52.00**	**2.50**	**7.28%**	**15,276**	**18.00**
7	Origami	ORIG 205	Fall	4	20	80	5.33	0.45	11.85	5.56	0.40	-4.80%	5,015	14
8	Origami	ORIG 205	Winter	4	21	84	5.60	0.50	11.20	5.86	0.50	-4.50%	7,798	14
9	Origami	ORIG 205	Spring	4	23	92	6.13	0.45	13.63	6.53	0.45	-6.00%	(662)	14
10	Origami	ORIG 380	Smr	4	25	100	6.67	0.50	13.33	7.05	0.40	-5.10%	468	14
11	**Origami Discipline Area Roll-Up**						**23.73**	**1.90**	**12.49**	**25.00**	**1.75**	**-5.12%**	**12,619**	**14.00**
12	Balloons	BALL 320	Fall	2	155	310	20.67	1.25	16.53	24.00	1.45	2.10%	22,393	20
13	Balloons	BALL 330	Winter	2	147	294	19.60	1.20	16.33	22.50	1.40	1.97%	22,387	20
14	Balloons	BALL 450	Spring	2	152	304	20.27	1.20	16.89	23.10	1.45	1.87%	19,325	20
15	Balloons	BALL 330	Smr	2	150	300	20.00	1.20	16.67	20.80	1.20	2.20%	21,017	20
16	**Balloons Discipline Area Roll-Up**						**80.53**	**4.85**	**16.60**	**90.40**	**5.50**	**2.04%**	**85,122**	**20.00**
17	Presents	PRES 100	Fall	3	5	15	1.00	0.20	5.00	2.00	0.20	-12.20%	8,732	10
18	Presents	PRES 100	Winter	3	10	30	2.00	0.20	10.00	2.00	0.20	-13.10%	(576)	10
19	Presents	PRES 100	Spring	3	8	24	1.60	0.20	8.00	1.80	0.20	-13.54%	3,123	10
20	Presents	PRES 450	Smr	3	10	30	2.00	0.20	10.00	1.80	0.20	-10.00%	(440)	10
21	**Presents Discipline Area Roll-Up**						**6.60**	**0.80**	**8.25**	**7.60**	**0.80**	**-12.13%**	**10,839**	**10.00**
22	Games	GAMS 180	Fall	3	34	102	6.80	0.45	15.11	6.59	0.45	11.50%	15,139	20
23	Games	GAMS 190	Winter	3	35	105	7.00	0.45	15.56	6.76	0.40	13.20%	15,191	20
24	Games	GAMS 260	Spring	3	40	120	8.00	0.45	17.78	7.78	0.40	12.05%	10,959	20
25	Games	GAMS 260	Smr	3	36	108	7.20	0.25	28.80	4.87	0.25	11.80%	(2,686)	20
26	**Games Discipline Area Roll-Up**						**29.00**	**1.60**	**18.13**	**26.00**	**1.50**	**12.14%**	**38,603**	**20.00**
27														
28	**Dept Roll-Ups within College A**						FTES	FTEF	SFR	FTES	FTEF	%FTES	CM 2→3	Max. SFR
29	Department A1 Roll-Up						195.87	12.15	16.12	201.00	12.05	3.69%	162,459	18.06
30	Department A2 Roll-Up						450.20	18.00	25.01	458.80	17.20	-2.00%	(197,496)	23.12
31	Department A3 Roll-Up						895.00	45.80	19.54	870.60	44.20	1.50%	270,488	20.43
32														
33	**College Roll-Ups with Division**						FTES	FTEF	SFR	FTES	FTEF	%FTES	CM 2→3	Max. SFR
34	College A Roll-Up						1541.07	75.95	20.29	1530.40	73.45	0.76%	235,451	20.76
35	College B Roll-Up						5256.00	245.30	21.43	5407.00	240.30	-0.04%	(220,012)	21.00
36	College C Roll-Up						3418.00	181.72	18.81	3568.00	183.80	-1.43%	1,016,103	20.50
37	College D Roll-Up						2310.00	130.30	17.73	2281.10	125.80	1.13%	(800,724)	16.40
38														
39	**Division Roll-Up**						FTES	FTEF	SFR	FTES	FTEF	%FTES	CM 2→3	Max. SFR
40							12525.07	633.27	19.78	12786.50	623.35	-0.11%	230,818	20.25

Table 1: Illustrative Data

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	52.00	2.50	20.80	357,400
2	8000	32	100	90,000	56.00	3.00	18.67	357,200
3	8000	32	100	90,000	60.1	3.34	18.00	372,476
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-10.26%	7.69%	20.00%	4.00	0.50	(200)	-2.13	(25,714)
2→3	-3.57%	7.28%	11.25%	4.08	0.34	15,276	-0.67	(10,000)



Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	-7.00%	-6.00%	-5.00%	-4.00%	-3.00%	-2.00%	-1.00%	ΔFTES
11.00%	18,969	22,058	25,081	28,042	30,941	33,782	36,565	6.16
10.00%	15,397	18,486	21,509	24,470	27,369	30,210	32,993	5.60
9.00%	11,825	14,914	17,937	20,898	23,797	26,638	29,421	5.04
8.00%	8,253	11,342	14,365	17,326	20,225	23,066	25,849	4.48
7.00%	4,681	7,770	10,793	13,754	16,653	19,494	22,277	3.92
6.00%	1,109	4,198	7,221	10,182	13,081	15,922	18,705	3.36
5.00%	(2,463)	626	3,649	6,610	9,509	12,350	15,133	2.80
4.00%	(6,035)	(2,946)	77	3,038	5,937	8,778	11,561	2.24
3.00%	(9,607)	(6,518)	(3,495)	(534)	2,365	5,206	7,989	1.68

Heat Map for Change in FTEF (2→3)

	% ΔSFR							
% ΔFTES	-7.00%	-6.00%	-5.00%	-4.00%	-3.00%	-2.00%	-1.00%	ΔFTES
11.00%	0.58	0.54	0.51	0.47	0.43	0.40	0.36	6.16
10.00%	0.55	0.51	0.47	0.44	0.40	0.37	0.33	5.60
9.00%	0.52	0.48	0.44	0.41	0.37	0.34	0.30	5.04
8.00%	0.48	0.45	0.41	0.38	0.34	0.31	0.27	4.48
7.00%	0.45	0.41	0.38	0.34	0.31	0.28	0.24	3.92
6.00%	0.42	0.38	0.35	0.31	0.28	0.24	0.21	3.36
5.00%	0.39	0.35	0.32	0.28	0.25	0.21	0.18	2.80
4.00%	0.35	0.32	0.28	0.25	0.22	0.18	0.15	2.24
3.00%	0.32	0.29	0.25	0.22	0.19	0.15	0.12	1.68
	-1.31	-1.12	-0.93	-0.75	-0.56	-0.37	-0.19	
				ΔSFR				

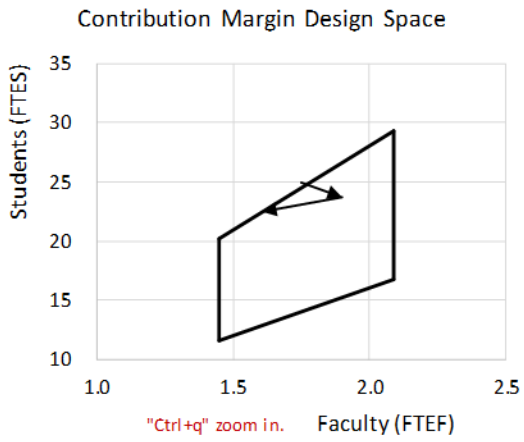
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 5%

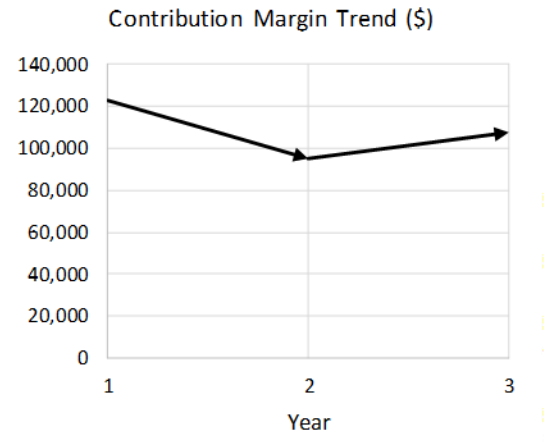
Figure 2: Candles

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

0.20

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	25.00	1.75	14.29	122,500
2	8000	32	100	90,000	23.73	1.90	12.49	94,776
3	8000	32	100	90,000	22.5	1.61	14.00	107,395
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-12.57%	-5.08%	8.57%	-1.27	0.15	(27,724)	-1.80	(22,652)
2→3	12.09%	-5.15%	-15.38%	-1.22	-0.29	12,619	1.51	18,450





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	9.00%	10.00%	11.00%	12.00%	13.00%	14.00%	15.00%	ΔFTES
-1.00%	13,172	14,598	15,998	17,374	18,725	20,052	21,357	(0.24)
-2.00%	12,224	13,650	15,050	16,426	17,777	19,104	20,409	(0.47)
-3.00%	11,276	12,702	14,103	15,478	16,829	18,157	19,461	(0.71)
-4.00%	10,328	11,754	13,155	14,530	15,882	17,209	18,513	(0.95)
-5.00%	9,380	10,807	12,207	13,583	14,934	16,261	17,566	(1.19)
-6.00%	8,433	9,859	11,259	12,635	13,986	15,313	16,618	(1.42)
-7.00%	7,485	8,911	10,312	11,687	13,038	14,366	15,670	(1.66)
-8.00%	6,537	7,963	9,364	10,739	12,090	13,418	14,722	(1.90)
-9.00%	5,589	7,016	8,416	9,792	11,143	12,470	13,775	(2.14)

Heat Map for Change in FTEF (2→3)

	% ΔSFR							
% ΔFTES	9.00%	10.00%	11.00%	12.00%	13.00%	14.00%	15.00%	ΔFTES
-1.00%	(0.17)	(0.19)	(0.21)	(0.22)	(0.24)	(0.25)	(0.26)	(0.24)
-2.00%	(0.19)	(0.21)	(0.22)	(0.24)	(0.25)	(0.27)	(0.28)	(0.47)
-3.00%	(0.21)	(0.22)	(0.24)	(0.25)	(0.27)	(0.28)	(0.30)	(0.71)
-4.00%	(0.23)	(0.24)	(0.26)	(0.27)	(0.29)	(0.30)	(0.31)	(0.95)
-5.00%	(0.24)	(0.26)	(0.27)	(0.29)	(0.30)	(0.32)	(0.33)	(1.19)
-6.00%	(0.26)	(0.28)	(0.29)	(0.31)	(0.32)	(0.33)	(0.35)	(1.42)
-7.00%	(0.28)	(0.29)	(0.31)	(0.32)	(0.34)	(0.35)	(0.36)	(1.66)
-8.00%	(0.30)	(0.31)	(0.33)	(0.34)	(0.35)	(0.37)	(0.38)	(1.90)
-9.00%	(0.31)	(0.33)	(0.34)	(0.36)	(0.37)	(0.38)	(0.40)	(2.14)
	1.12	1.25	1.37	1.50	1.62	1.75	1.87	
				ΔSFR				

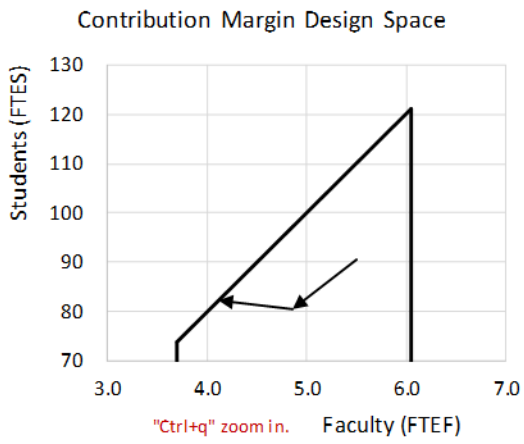
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 4%

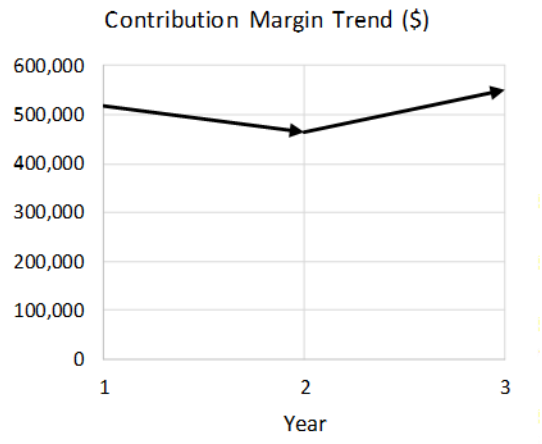
Figure 3: Origami

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

0.20

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	90.40	5.50	16.44	517,480
2	8000	32	100	90,000	80.53	4.85	16.60	465,436
3	8000	32	100	90,000	82.2	4.11	20.00	550,558
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	1.02%	-10.92%	-11.82%	-9.87	-0.65	(52,044)	0.17	5,001
2→3	20.45%	2.04%	-15.29%	1.64	-0.74	85,122	3.40	74,115





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	17.00%	18.00%	19.00%	20.00%	21.00%	22.00%	23.00%	ΔFTES
6.00%	91,349	94,511	97,619	100,676	103,682	106,639	109,548	4.83
5.00%	86,695	89,857	92,965	96,022	99,028	101,985	104,894	4.03
4.00%	82,041	85,202	88,311	91,367	94,374	97,331	100,240	3.22
3.00%	77,386	80,548	83,656	86,713	89,719	92,676	95,585	2.42
2.00%	72,732	75,893	79,002	82,059	85,065	88,022	90,931	1.61
1.00%	68,077	71,239	74,348	77,404	80,411	83,368	86,276	0.81
0.00%	63,423	66,585	69,693	72,750	75,756	78,713	81,622	-
-1.00%	58,769	61,930	65,039	68,096	71,102	74,059	76,968	(0.81)
-2.00%	54,114	57,276	60,385	63,441	66,448	69,404	72,313	(1.61)

Heat Map for Change in FTEF (2→3)

	% ΔSFR							
% ΔFTES	17.00%	18.00%	19.00%	20.00%	21.00%	22.00%	23.00%	ΔFTES
6.00%	(0.46)	(0.49)	(0.53)	(0.57)	(0.60)	(0.64)	(0.67)	4.83
5.00%	(0.50)	(0.53)	(0.57)	(0.61)	(0.64)	(0.68)	(0.71)	4.03
4.00%	(0.54)	(0.58)	(0.61)	(0.65)	(0.68)	(0.72)	(0.75)	3.22
3.00%	(0.58)	(0.62)	(0.65)	(0.69)	(0.72)	(0.76)	(0.79)	2.42
2.00%	(0.62)	(0.66)	(0.69)	(0.73)	(0.76)	(0.80)	(0.83)	1.61
1.00%	(0.66)	(0.70)	(0.73)	(0.77)	(0.80)	(0.83)	(0.87)	0.81
0.00%	(0.70)	(0.74)	(0.77)	(0.81)	(0.84)	(0.87)	(0.91)	-
-1.00%	(0.75)	(0.78)	(0.82)	(0.85)	(0.88)	(0.91)	(0.95)	(0.81)
-2.00%	(0.79)	(0.82)	(0.86)	(0.89)	(0.92)	(0.95)	(0.99)	(1.61)
	2.82	2.99	3.15	3.32	3.49	3.65	3.82	
				ΔSFR				

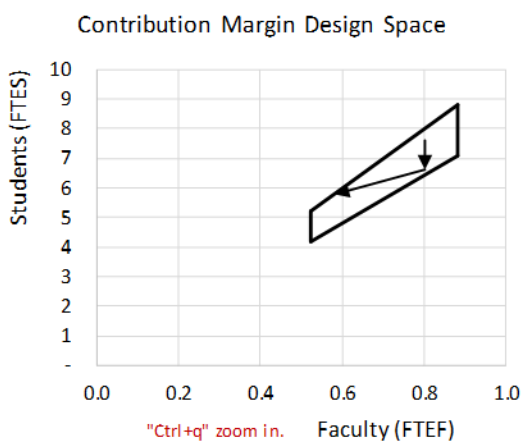
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 1%

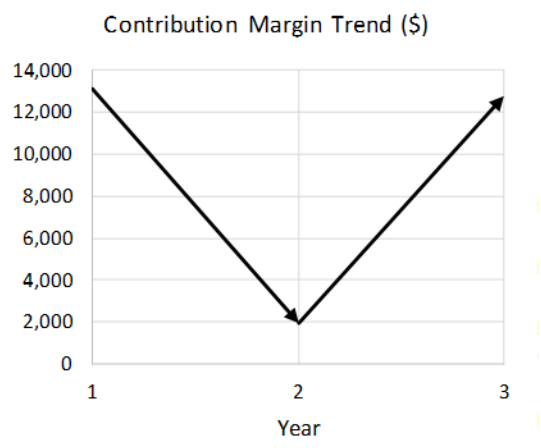
Figure 4: Balloons

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

0.20

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	7.60	0.80	9.50	13,120
2	8000	32	100	90,000	6.60	0.80	8.25	1,920
3	8000	32	100	90,000	5.8	0.58	10.00	12,759
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-13.16%	-13.16%	0.00%	-1.00	0.00	(11,200)	-1.25	(10,909)
2→3	21.21%	-12.13%	-27.51%	-0.80	-0.22	10,839	1.75	12,600





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	18.00%	19.00%	20.00%	21.00%	22.00%	23.00%	24.00%	ΔFTES
-8.00%	10,829	11,342	11,846	12,342	12,830	13,310	13,782	(0.53)
-9.00%	10,810	11,323	11,827	12,323	12,811	13,291	13,763	(0.59)
-10.00%	10,791	11,304	11,808	12,304	12,792	13,271	13,744	(0.66)
-11.00%	10,772	11,285	11,789	12,285	12,772	13,252	13,724	(0.73)
-12.00%	10,753	11,265	11,770	12,265	12,753	13,233	13,705	(0.79)
-13.00%	10,733	11,246	11,750	12,246	12,734	13,214	13,686	(0.86)
-14.00%	10,714	11,227	11,731	12,227	12,715	13,195	13,667	(0.92)
-15.00%	10,695	11,208	11,712	12,208	12,696	13,175	13,648	(0.99)
-16.00%	10,676	11,189	11,693	12,189	12,676	13,156	13,628	(1.06)

Heat Map for Change in FTEF (2→3)

	% ΔSFR							
% ΔFTES	18.00%	19.00%	20.00%	21.00%	22.00%	23.00%	24.00%	ΔFTES
-8.00%	(0.18)	(0.18)	(0.19)	(0.19)	(0.20)	(0.20)	(0.21)	(0.53)
-9.00%	(0.18)	(0.19)	(0.19)	(0.20)	(0.20)	(0.21)	(0.21)	(0.59)
-10.00%	(0.19)	(0.19)	(0.20)	(0.20)	(0.21)	(0.21)	(0.22)	(0.66)
-11.00%	(0.20)	(0.20)	(0.21)	(0.21)	(0.22)	(0.22)	(0.23)	(0.73)
-12.00%	(0.20)	(0.21)	(0.21)	(0.22)	(0.22)	(0.23)	(0.23)	(0.79)
-13.00%	(0.21)	(0.22)	(0.22)	(0.22)	(0.23)	(0.23)	(0.24)	(0.86)
-14.00%	(0.22)	(0.22)	(0.23)	(0.23)	(0.24)	(0.24)	(0.25)	(0.92)
-15.00%	(0.22)	(0.23)	(0.23)	(0.24)	(0.24)	(0.25)	(0.25)	(0.99)
-16.00%	(0.23)	(0.24)	(0.24)	(0.24)	(0.25)	(0.25)	(0.26)	(1.06)
	1.49	1.57	1.65	1.73	1.82	1.90	1.98	
				ΔSFR				

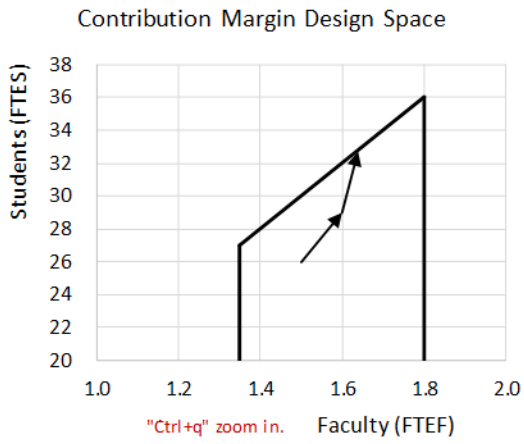
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 13%

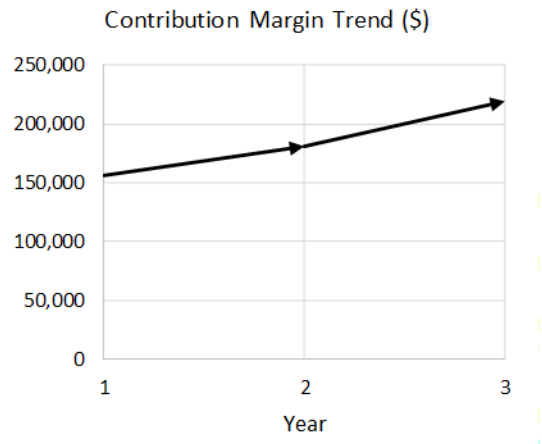
Figure 5: Presents

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	26.00	1.50	17.33	156,200
2	8000	32	100	90,000	29.00	1.60	18.13	180,800
3	8000	32	100	90,000	32.7	1.64	20.00	219,403

	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	4.57%	11.54%	6.67%	3.00	0.10	24,600	0.79	5,897
2→3	10.34%	12.92%	2.33%	3.75	0.04	38,603	1.88	13,500





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	7.00%	8.00%	9.00%	10.00%	11.00%	12.00%	13.00%	ΔFTES
17.00%	40,157	41,403	42,626	43,827	45,006	46,165	47,302	4.93
16.00%	38,349	39,595	40,818	42,019	43,198	44,357	45,494	4.64
15.00%	36,541	37,787	39,010	40,211	41,390	42,549	43,686	4.35
14.00%	34,733	35,979	37,202	38,403	39,582	40,741	41,878	4.06
13.00%	32,925	34,171	35,394	36,595	37,774	38,933	40,070	3.77
12.00%	31,117	32,363	33,586	34,787	35,966	37,125	38,262	3.48
11.00%	29,309	30,555	31,778	32,979	34,158	35,317	36,454	3.19
10.00%	27,501	28,747	29,970	31,171	32,350	33,509	34,646	2.90
9.00%	25,693	26,939	28,162	29,363	30,542	31,701	32,838	2.61

Heat Map for Change in FTEF (2→3)

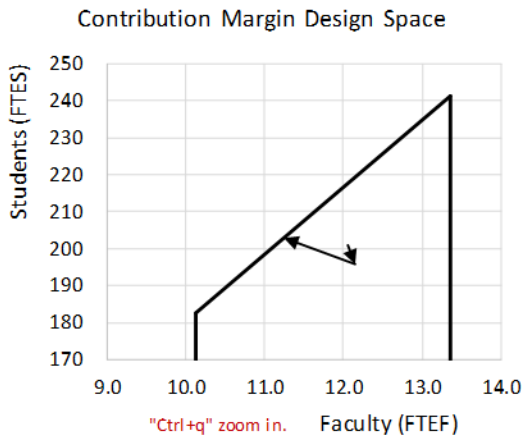
	% ΔSFR							
% ΔFTES	7.00%	8.00%	9.00%	10.00%	11.00%	12.00%	13.00%	ΔFTES
17.00%	0.15	0.13	0.12	0.10	0.09	0.07	0.06	4.93
16.00%	0.13	0.12	0.10	0.09	0.07	0.06	0.04	4.64
15.00%	0.12	0.10	0.09	0.07	0.06	0.04	0.03	4.35
14.00%	0.10	0.09	0.07	0.06	0.04	0.03	0.01	4.06
13.00%	0.09	0.07	0.06	0.04	0.03	0.01	-	3.77
12.00%	0.07	0.06	0.04	0.03	0.01	-	(0.01)	3.48
11.00%	0.06	0.04	0.03	0.01	-	(0.01)	(0.03)	3.19
10.00%	0.04	0.03	0.01	-	(0.01)	(0.03)	(0.04)	2.90
9.00%	0.03	0.01	-	(0.01)	(0.03)	(0.04)	(0.06)	2.61
	1.27	1.45	1.63	1.81	1.99	2.18	2.36	
				ΔSFR				

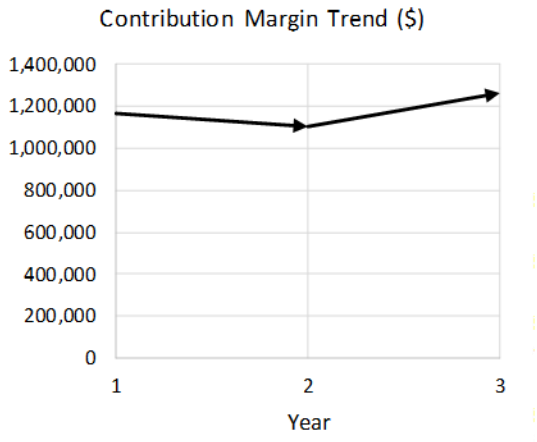
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 3%

Figure 6: Games

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	201.00	12.05	16.68	1,166,700
2	8000	32	100	90,000	195.87	12.15	16.12	1,100,244
3	8000	32	100	90,000	203.1	11.24	18.06	1,262,703
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-3.35%	-2.55%	0.83%	-5.13	0.10	(66,456)	-0.56	(37,640)
2→3	12.06%	3.68%	-7.47%	7.21	-0.91	162,459	1.94	117,641





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	9.00%	10.00%	11.00%	12.00%	13.00%	14.00%	15.00%	ΔFTES
8.00%	178,309	187,429	196,384	205,180	213,820	222,309	230,650	15.67
7.00%	167,306	176,426	185,382	194,178	202,818	211,307	219,648	13.71
6.00%	156,304	165,424	174,380	183,175	191,816	200,304	208,645	11.75
5.00%	145,301	154,421	163,377	172,173	180,813	189,302	197,643	9.79
4.00%	134,299	143,419	152,375	161,170	169,811	178,299	186,640	7.83
3.00%	123,296	132,416	141,372	150,168	158,808	167,297	175,638	5.88
2.00%	112,294	121,414	130,370	139,166	147,806	156,294	164,635	3.92
1.00%	101,291	110,412	119,367	128,163	136,803	145,292	153,633	1.96
0.00%	90,289	99,409	108,365	117,161	125,801	134,289	142,630	-

Heat Map for Change in FTEF (2→3)

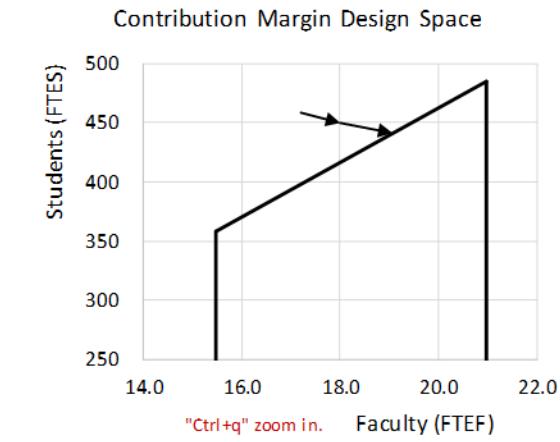
	% ΔSFR							
% ΔFTES	9.00%	10.00%	11.00%	12.00%	13.00%	14.00%	15.00%	ΔFTES
8.00%	(0.11)	(0.22)	(0.33)	(0.43)	(0.54)	(0.64)	(0.74)	15.67
7.00%	(0.22)	(0.33)	(0.44)	(0.54)	(0.65)	(0.75)	(0.85)	13.71
6.00%	(0.33)	(0.44)	(0.55)	(0.65)	(0.75)	(0.85)	(0.95)	11.75
5.00%	(0.45)	(0.55)	(0.66)	(0.76)	(0.86)	(0.96)	(1.06)	9.79
4.00%	(0.56)	(0.66)	(0.77)	(0.87)	(0.97)	(1.07)	(1.16)	7.83
3.00%	(0.67)	(0.77)	(0.88)	(0.98)	(1.08)	(1.17)	(1.27)	5.88
2.00%	(0.78)	(0.88)	(0.99)	(1.08)	(1.18)	(1.28)	(1.37)	3.92
1.00%	(0.89)	(0.99)	(1.09)	(1.19)	(1.29)	(1.39)	(1.48)	1.96
0.00%	(1.00)	(1.10)	(1.20)	(1.30)	(1.40)	(1.49)	(1.58)	-
	1.45	1.61	1.77	1.93	2.10	2.26	2.42	
				ΔSFR				

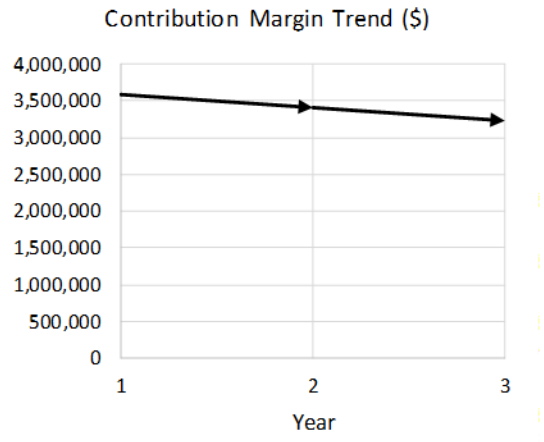
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 1%

Figure 7: Department A1

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	458.80	17.20	26.67	3,590,560
2	8000	32	100	90,000	450.00	18.00	25.00	3,420,000
3	8000	32	100	90,000	441.0	19.07	23.12	3,222,504
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-6.28%	-1.92%	4.65%	-8.80	0.80	(170,560)	-1.67	(103,680)
2→3	-7.52%	-2.00%	5.97%	-9.00	1.07	(197,496)	-1.88	(131,730)





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	-11.00%	-10.00%	-9.00%	-8.00%	-7.00%	-6.00%	-5.00%	ΔFTES
2.00%	(131,825)	(111,600)	(91,820)	(72,470)	(53,535)	(35,004)	(16,863)	9.00
1.00%	(166,025)	(145,800)	(126,020)	(106,670)	(87,735)	(69,204)	(51,063)	4.50
0.00%	(200,225)	(180,000)	(160,220)	(140,870)	(121,935)	(103,404)	(85,263)	-
-1.00%	(234,425)	(214,200)	(194,420)	(175,070)	(156,135)	(137,604)	(119,463)	(4.50)
-2.00%	(268,625)	(248,400)	(228,620)	(209,270)	(190,335)	(171,804)	(153,663)	(9.00)
-3.00%	(302,825)	(282,600)	(262,820)	(243,470)	(224,535)	(206,004)	(187,863)	(13.50)
-4.00%	(337,025)	(316,800)	(297,020)	(277,670)	(258,735)	(240,204)	(222,063)	(18.00)
-5.00%	(371,225)	(351,000)	(331,220)	(311,870)	(292,935)	(274,404)	(256,263)	(22.50)
-6.00%	(405,425)	(385,200)	(365,420)	(346,070)	(327,135)	(308,604)	(290,463)	(27.00)

Heat Map for Change in FTEF (2→3)

	% ΔSFR							
% ΔFTES	-11.00%	-10.00%	-9.00%	-8.00%	-7.00%	-6.00%	-5.00%	ΔFTES
2.00%	2.63	2.40	2.18	1.96	1.74	1.53	1.33	9.00
1.00%	2.43	2.20	1.98	1.76	1.55	1.34	1.14	4.50
0.00%	2.22	2.00	1.78	1.57	1.35	1.15	0.95	-
-1.00%	2.02	1.80	1.58	1.37	1.16	0.96	0.76	(4.50)
-2.00%	1.82	1.60	1.38	1.17	0.97	0.77	0.57	(9.00)
-3.00%	1.62	1.40	1.19	0.98	0.77	0.57	0.38	(13.50)
-4.00%	1.42	1.20	0.99	0.78	0.58	0.38	0.19	(18.00)
-5.00%	1.21	1.00	0.79	0.59	0.39	0.19	-	(22.50)
-6.00%	1.01	0.80	0.59	0.39	0.19	-	(0.19)	(27.00)
	-2.75	-2.50	-2.25	-2.00	-1.75	-1.50	-1.25	
				ΔSFR				

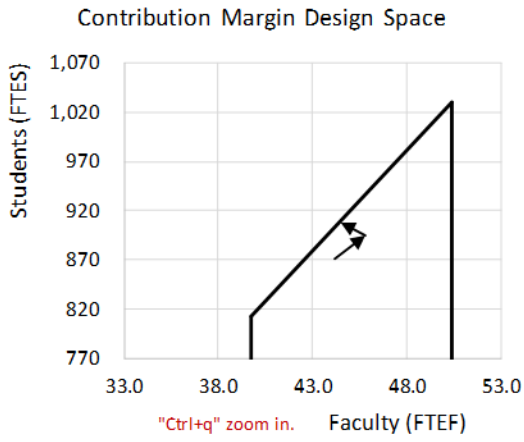
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 1%

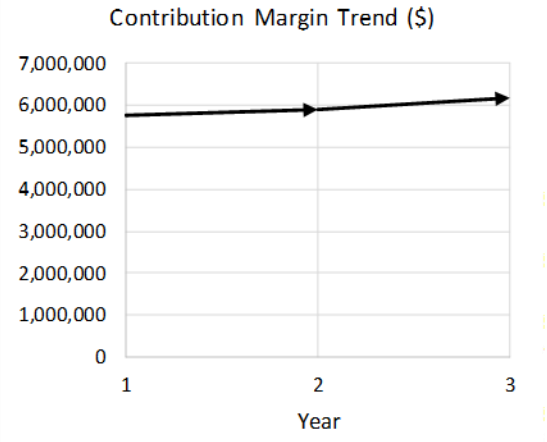
Figure 8: Department A2

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	870.60	44.20	19.70	5,772,720
2	8000	32	100	90,000	895.00	45.80	19.54	5,902,000
3	8000	32	100	90,000	908.4	44.47	20.43	6,172,488

	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-0.79%	2.80%	3.62%	24.40	1.60	129,280	-0.16	(31,624)
2→3	4.55%	1.50%	-2.91%	13.43	-1.33	270,488	0.89	179,269





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	2.00%	3.00%	4.00%	5.00%	6.00%	7.00%	8.00%	ΔFTES
6.00%	434,944	474,178	512,658	550,406	587,441	623,784	659,453	53.70
5.00%	375,924	415,158	453,638	491,386	528,421	564,764	600,433	44.75
4.00%	316,904	356,138	394,618	432,366	469,401	505,744	541,413	35.80
3.00%	257,884	297,118	335,598	373,346	410,381	446,724	482,393	26.85
2.00%	198,864	238,098	276,578	314,326	351,361	387,704	423,373	17.90
1.00%	139,844	179,078	217,558	255,306	292,341	328,684	364,353	8.95
0.00%	80,824	120,058	158,538	196,286	233,321	269,664	305,333	-
-1.00%	21,804	61,038	99,518	137,266	174,301	210,644	246,313	(8.95)
-2.00%	(37,216)	2,018	40,498	78,246	115,281	151,624	187,293	(17.90)

Heat Map for Change in FTEF (2→3)

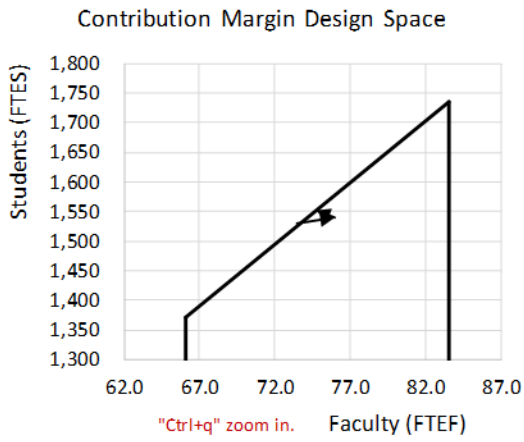
	% ΔSFR							
% ΔFTES	2.00%	3.00%	4.00%	5.00%	6.00%	7.00%	8.00%	ΔFTES
6.00%	1.80	1.33	0.88	0.44	-	(0.43)	(0.85)	53.70
5.00%	1.35	0.89	0.44	-	(0.43)	(0.86)	(1.27)	44.75
4.00%	0.90	0.44	-	(0.44)	(0.86)	(1.28)	(1.70)	35.80
3.00%	0.45	-	(0.44)	(0.87)	(1.30)	(1.71)	(2.12)	26.85
2.00%	-	(0.44)	(0.88)	(1.31)	(1.73)	(2.14)	(2.54)	17.90
1.00%	(0.45)	(0.89)	(1.32)	(1.74)	(2.16)	(2.57)	(2.97)	8.95
0.00%	(0.90)	(1.33)	(1.76)	(2.18)	(2.59)	(3.00)	(3.39)	-
-1.00%	(1.35)	(1.78)	(2.20)	(2.62)	(3.02)	(3.42)	(3.82)	(8.95)
-2.00%	(1.80)	(2.22)	(2.64)	(3.05)	(3.46)	(3.85)	(4.24)	(17.90)
	0.39	0.59	0.78	0.98	1.17	1.37	1.56	
				ΔSFR				

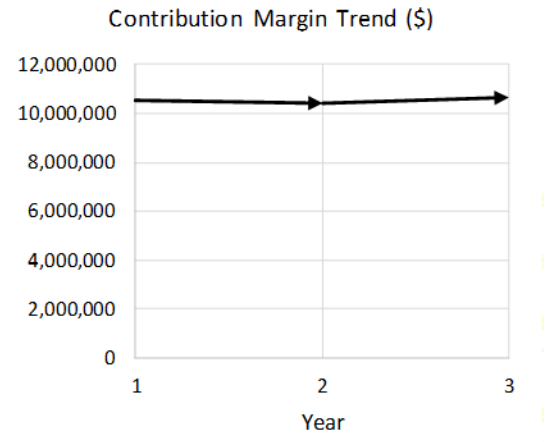
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 1%

Figure 9: Department A3

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	1,530.40	73.45	20.84	10,529,980
2	8000	32	100	90,000	1,541.07	75.95	20.29	10,424,484
3	8000	32	100	90,000	1,552.6	74.77	20.76	10,659,934
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-2.62%	0.70%	3.40%	10.67	2.50	(105,496)	-0.55	(177,673)
2→3	2.34%	0.75%	-1.55%	11.56	-1.18	235,450	0.47	156,095





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	-1.00%	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	ΔFTES
5.00%	452,179	521,224	588,902	655,254	720,316	784,128	846,724	77.05
4.00%	347,934	416,979	484,658	551,009	616,072	679,883	742,479	61.64
3.00%	243,689	312,735	380,413	446,764	511,827	575,638	638,235	46.23
2.00%	139,444	208,490	276,168	342,519	407,582	471,394	533,990	30.82
1.00%	35,199	104,245	171,923	238,274	303,337	367,149	429,745	15.41
0.00%	(69,045)	-	67,678	134,029	199,092	262,904	325,500	-
-1.00%	(173,290)	(104,245)	(36,567)	29,785	94,847	158,659	221,255	(15.41)
-2.00%	(277,535)	(208,490)	(140,811)	(74,460)	(9,397)	54,414	117,010	(30.82)
-3.00%	(381,780)	(312,735)	(245,056)	(178,705)	(113,642)	(49,831)	12,765	(46.23)

Heat Map for Change in FTEF (2→3)

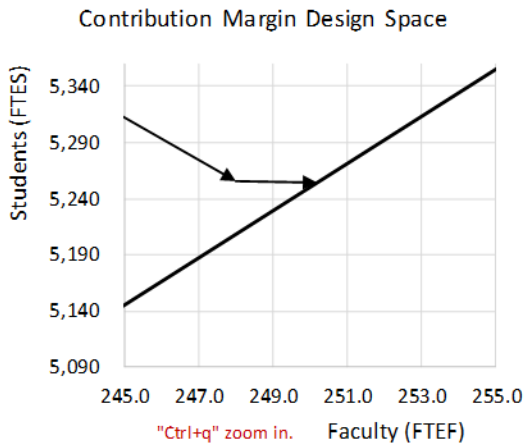
	% ΔSFR							
% ΔFTES	-1.00%	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	ΔFTES
5.00%	4.60	3.80	3.01	2.23	1.47	0.73	-	77.05
4.00%	3.84	3.04	2.26	1.49	0.74	-	(0.72)	61.64
3.00%	3.07	2.28	1.50	0.74	-	(0.73)	(1.45)	46.23
2.00%	2.30	1.52	0.75	-	(0.74)	(1.46)	(2.17)	30.82
1.00%	1.53	0.76	-	(0.74)	(1.47)	(2.19)	(2.89)	15.41
0.00%	0.77	-	(0.75)	(1.49)	(2.21)	(2.92)	(3.62)	-
-1.00%	-	(0.76)	(1.50)	(2.23)	(2.95)	(3.65)	(4.34)	(15.41)
-2.00%	(0.77)	(1.52)	(2.26)	(2.98)	(3.69)	(4.38)	(5.06)	(30.82)
-3.00%	(1.53)	(2.28)	(3.01)	(3.72)	(4.42)	(5.11)	(5.79)	(46.23)
	-0.20	0.00	0.20	0.41	0.61	0.81	1.01	
				ΔSFR				

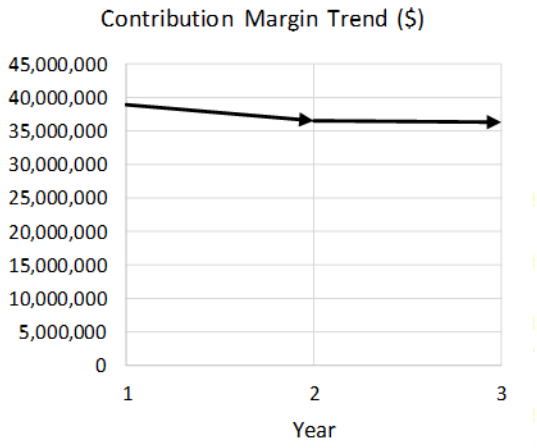
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 0%

Figure 10: College A

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	5,407.00	240.00	22.53	38,958,400
2	8000	32	100	90,000	5,256.00	248.00	21.19	36,547,200
3	8000	32	100	90,000	5,253.9	250.18	21.00	36,327,188
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-5.93%	-2.79%	3.33%	-151.00	8.00	(2,411,200)	-1.34	(1,361,233)
2→3	-0.91%	-0.04%	0.88%	-2.10	2.18	(220,012)	-0.19	(205,475)





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	-4.00%	-3.00%	-2.00%	-1.00%	0.00%	1.00%	2.00%	ΔFTES
4.00%	531,888	771,579	1,006,378	1,236,433	1,461,888	1,682,878	1,899,535	210.24
3.00%	166,416	406,107	640,906	870,961	1,096,416	1,317,406	1,534,063	157.68
2.00%	(199,056)	40,635	275,434	505,489	730,944	951,934	1,168,591	105.12
1.00%	(564,528)	(324,837)	(90,038)	140,017	365,472	586,462	803,119	52.56
0.00%	(930,000)	(690,309)	(455,510)	(225,455)	-	220,990	437,647	-
-1.00%	(1,295,472)	(1,055,781)	(820,982)	(590,927)	(365,472)	(144,482)	72,175	(52.56)
-2.00%	(1,660,944)	(1,421,253)	(1,186,454)	(956,399)	(730,944)	(509,954)	(293,297)	(105.12)
-3.00%	(2,026,416)	(1,786,725)	(1,551,926)	(1,321,871)	(1,096,416)	(875,426)	(658,769)	(157.68)
-4.00%	(2,391,888)	(2,152,197)	(1,917,398)	(1,687,343)	(1,461,888)	(1,240,898)	(1,024,241)	(210.24)

Heat Map for Change in FTEF (2→3)

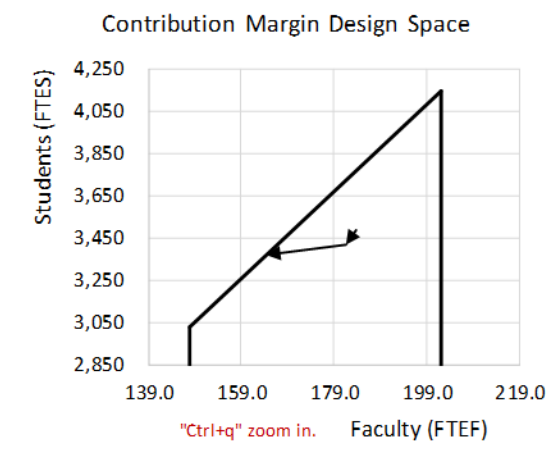
	% ΔSFR							
% ΔFTES	-4.00%	-3.00%	-2.00%	-1.00%	0.00%	1.00%	2.00%	ΔFTES
4.00%	20.67	17.90	15.18	12.53	9.92	7.37	4.86	210.24
3.00%	18.08	15.34	12.65	10.02	7.44	4.91	2.43	157.68
2.00%	15.50	12.78	10.12	7.52	4.96	2.46	-	105.12
1.00%	12.92	10.23	7.59	5.01	2.48	-	(2.43)	52.56
0.00%	10.33	7.67	5.06	2.51	-	(2.46)	(4.86)	-
-1.00%	7.75	5.11	2.53	-	(2.48)	(4.91)	(7.29)	(52.56)
-2.00%	5.17	2.56	-	(2.51)	(4.96)	(7.37)	(9.73)	(105.12)
-3.00%	2.58	-	(2.53)	(5.01)	(7.44)	(9.82)	(12.16)	(157.68)
-4.00%	-	(2.56)	(5.06)	(7.52)	(9.92)	(12.28)	(14.59)	(210.24)
	-0.85	-0.64	-0.42	-0.21	0.00	0.21	0.42	
				ΔSFR				

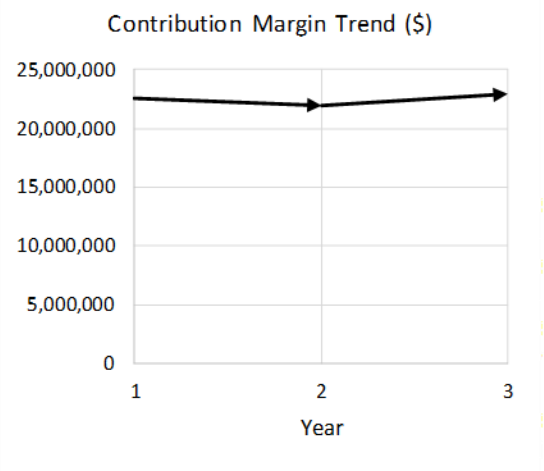
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 0%

Figure 11: College B

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	3,490.30	183.80	18.99	22,549,360
2	8000	32	100	90,000	3,418.00	181.72	18.81	21,926,800
3	8000	32	100	90,000	3,369.1	164.35	20.50	22,942,903
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-0.95%	-2.07%	-1.13%	-72.30	-2.08	(622,560)	-0.18	(158,749)
2→3	8.99%	-1.43%	-9.56%	-48.88	-17.37	1,016,103	1.69	1,348,946





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	6.00%	7.00%	8.00%	9.00%	10.00%	11.00%	12.00%	ΔFTES
3.00%	1,583,547	1,727,744	1,869,271	2,008,200	2,144,604	2,278,550	2,410,104	102.54
2.00%	1,364,279	1,508,476	1,650,003	1,788,932	1,925,336	2,059,282	2,190,836	68.36
1.00%	1,145,011	1,289,208	1,430,735	1,569,664	1,706,068	1,840,014	1,971,568	34.18
0.00%	925,743	1,069,940	1,211,467	1,350,396	1,486,800	1,620,746	1,752,300	-
-1.00%	706,475	850,672	992,199	1,131,128	1,267,532	1,401,478	1,533,032	(34.18)
-2.00%	487,207	631,404	772,931	911,860	1,048,264	1,182,210	1,313,764	(68.36)
-3.00%	267,939	412,136	553,663	692,592	828,996	962,942	1,094,496	(102.54)
-4.00%	48,671	192,868	334,395	473,324	609,728	743,674	875,228	(136.72)
-5.00%	(170,597)	(26,400)	115,127	254,056	390,460	524,406	655,960	(170.90)

Heat Map for Change in FTEF (2→3)

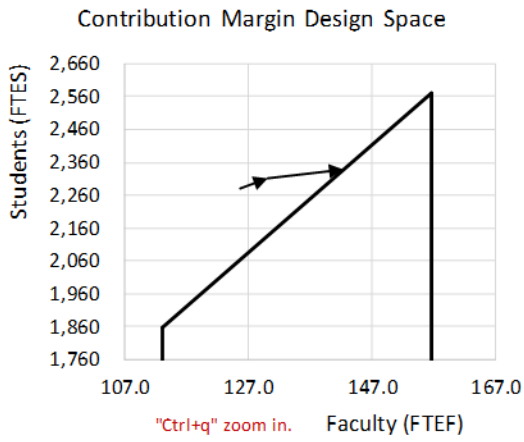
	% ΔSFR							
% ΔFTES	6.00%	7.00%	8.00%	9.00%	10.00%	11.00%	12.00%	ΔFTES
3.00%	(5.14)	(6.79)	(8.41)	(10.00)	(11.56)	(13.10)	(14.60)	102.54
2.00%	(6.86)	(8.49)	(10.10)	(11.67)	(13.22)	(14.73)	(16.23)	68.36
1.00%	(8.57)	(10.19)	(11.78)	(13.34)	(14.87)	(16.37)	(17.85)	34.18
0.00%	(10.29)	(11.89)	(13.46)	(15.00)	(16.52)	(18.01)	(19.47)	-
-1.00%	(12.00)	(13.59)	(15.14)	(16.67)	(18.17)	(19.65)	(21.09)	(34.18)
-2.00%	(13.71)	(15.28)	(16.83)	(18.34)	(19.82)	(21.28)	(22.72)	(68.36)
-3.00%	(15.43)	(16.98)	(18.51)	(20.01)	(21.48)	(22.92)	(24.34)	(102.54)
-4.00%	(17.14)	(18.68)	(20.19)	(21.67)	(23.13)	(24.56)	(25.96)	(136.72)
-5.00%	(18.86)	(20.38)	(21.87)	(23.34)	(24.78)	(26.19)	(27.58)	(170.90)
	1.13	1.32	1.50	1.69	1.88	2.07	2.26	
				ΔSFR				

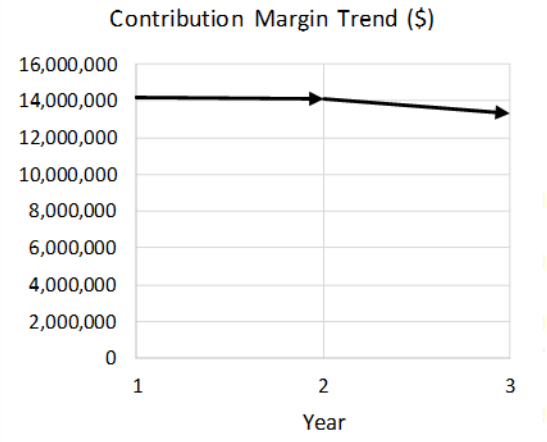
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 1%

Figure 12: College C

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	2,281.10	125.80	18.13	14,226,320
2	8000	32	100	90,000	2,310.00	130.30	17.73	14,145,000
3	8000	32	100	90,000	2,336.1	142.45	16.40	13,344,276
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-2.23%	1.27%	3.58%	28.90	4.50	(81,320)	-0.40	(258,286)
2→3	-7.49%	1.13%	9.32%	26.10	12.15	(800,724)	-1.33	(949,829)





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	-10.00%	-9.00%	-8.00%	-7.00%	-6.00%	-5.00%	-4.00%	ΔFTES
5.00%	(595,750)	(452,563)	(312,489)	(175,427)	(41,282)	90,039	218,625	115.50
4.00%	(737,200)	(594,013)	(453,939)	(316,877)	(182,732)	(51,411)	77,175	92.40
3.00%	(878,650)	(735,463)	(595,389)	(458,327)	(324,182)	(192,861)	(64,275)	69.30
2.00%	(1,020,100)	(876,913)	(736,839)	(599,777)	(465,632)	(334,311)	(205,725)	46.20
1.00%	(1,161,550)	(1,018,363)	(878,289)	(741,227)	(607,082)	(475,761)	(347,175)	23.10
0.00%	(1,303,000)	(1,159,813)	(1,019,739)	(882,677)	(748,532)	(617,211)	(488,625)	-
-1.00%	(1,444,450)	(1,301,263)	(1,161,189)	(1,024,127)	(889,982)	(758,661)	(630,075)	(23.10)
-2.00%	(1,585,900)	(1,442,713)	(1,302,639)	(1,165,577)	(1,031,432)	(900,111)	(771,525)	(46.20)
-3.00%	(1,727,350)	(1,584,163)	(1,444,089)	(1,307,027)	(1,172,882)	(1,041,561)	(912,975)	(69.30)

Heat Map for Change in FTEF (2→3)

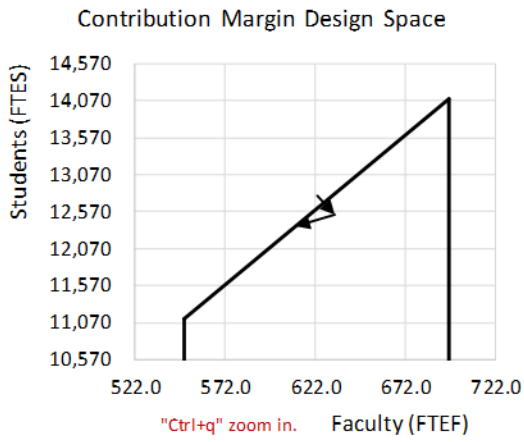
	% ΔSFR							
% ΔFTES	-10.00%	-9.00%	-8.00%	-7.00%	-6.00%	-5.00%	-4.00%	ΔFTES
5.00%	21.72	20.05	18.41	16.81	15.25	13.72	12.22	115.50
4.00%	20.27	18.61	17.00	15.41	13.86	12.34	10.86	92.40
3.00%	18.82	17.18	15.58	14.01	12.48	10.97	9.50	69.30
2.00%	17.37	15.75	14.16	12.61	11.09	9.60	8.14	46.20
1.00%	15.93	14.32	12.75	11.21	9.70	8.23	6.79	23.10
0.00%	14.48	12.89	11.33	9.81	8.32	6.86	5.43	-
-1.00%	13.03	11.45	9.91	8.41	6.93	5.49	4.07	(23.10)
-2.00%	11.58	10.02	8.50	7.01	5.54	4.11	2.71	(46.20)
-3.00%	10.13	8.59	7.08	5.60	4.16	2.74	1.36	(69.30)
	-1.77	-1.60	-1.42	-1.24	-1.06	-0.89	-0.71	
				ΔSFR				

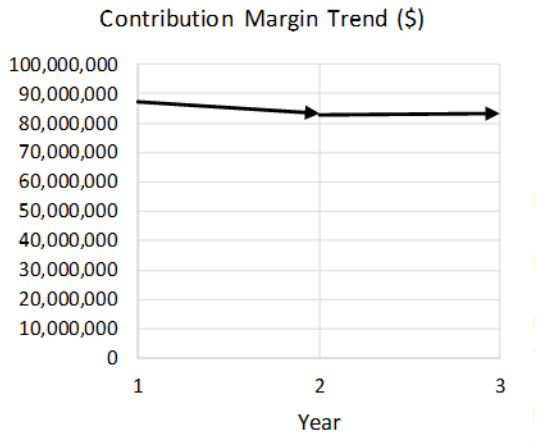
Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 1%

Figure 13: College D

Sandbox - Analysis for Change in Contribution Margin (not accounting for fixed costs)

	t	a	f	s	n	p	R	m
1	8000	32	100	90,000	12,786.50	623.35	20.51	87,107,300
2	8000	32	100	90,000	12,525.07	633.27	19.78	83,286,484
3	8000	32	100	90,000	12,364.7	610.75	20.25	83,517,302
	%ΔR	%Δn	%Δp	Δn	Δp	Δm	ΔR	Δm_ΔR
1→2	-3.58%	-2.04%	1.59%	-261.43	9.92	(3,820,816)	-0.73	(2,082,416)
2→3	2.36%	-1.28%	-3.56%	-160.32	-22.52	230,818	0.47	1,313,700





Heat Map for Change in Contribution Margin (2→3)

	% ΔSFR							
% ΔFTES	-1.00%	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	ΔFTES
3.00%	1,922,895	2,498,595	3,062,895	3,616,130	4,158,623	4,690,683	5,212,609	375.75
2.00%	1,090,030	1,665,730	2,230,030	2,783,265	3,325,758	3,857,818	4,379,744	250.50
1.00%	257,165	832,865	1,397,165	1,950,400	2,492,893	3,024,953	3,546,879	125.25
0.00%	(575,700)	-	564,300	1,117,535	1,660,028	2,192,088	2,714,014	-
-1.00%	(1,408,565)	(832,865)	(268,565)	284,670	827,163	1,359,224	1,881,149	(125.25)
-2.00%	(2,241,430)	(1,665,730)	(1,101,430)	(548,194)	(5,702)	526,359	1,048,285	(250.50)
-3.00%	(3,074,295)	(2,498,595)	(1,934,295)	(1,381,059)	(838,566)	(306,506)	215,420	(375.75)
-4.00%	(3,907,159)	(3,331,459)	(2,767,159)	(2,213,924)	(1,671,431)	(1,139,371)	(617,445)	(501.00)
-5.00%	(4,740,024)	(4,164,324)	(3,600,024)	(3,046,789)	(2,504,296)	(1,972,236)	(1,450,310)	(626.25)

Heat Map for Change in FTEF (2→3)

	% ΔSFR							
% ΔFTES	-1.00%	0.00%	1.00%	2.00%	3.00%	4.00%	5.00%	ΔFTES
3.00%	25.59	19.00	12.54	6.21	-	(6.09)	(12.06)	375.75
2.00%	19.19	12.67	6.27	-	(6.15)	(12.18)	(18.09)	250.50
1.00%	12.79	6.33	-	(6.21)	(12.30)	(18.27)	(24.12)	125.25
0.00%	6.40	-	(6.27)	(12.42)	(18.44)	(24.36)	(30.16)	-
-1.00%	-	(6.33)	(12.54)	(18.63)	(24.59)	(30.45)	(36.19)	(125.25)
-2.00%	(6.40)	(12.67)	(18.81)	(24.83)	(30.74)	(36.53)	(42.22)	(250.50)
-3.00%	(12.79)	(19.00)	(25.08)	(31.04)	(36.89)	(42.62)	(48.25)	(375.75)
-4.00%	(19.19)	(25.33)	(31.35)	(37.25)	(43.04)	(48.71)	(54.28)	(501.00)
-5.00%	(25.59)	(31.66)	(37.62)	(43.46)	(49.19)	(54.80)	(60.31)	(626.25)
	-0.20	0.00	0.20	0.40	0.59	0.79	0.99	
				ΔSFR				

Heat map numbers are based upon a 10th order Taylor series expansion model with error less than 1%

Figure 14: Division