Comfy Fuzzies

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Abstract

As one sleeps and goes through the various stages of a sleep cycle, the ideal temperature enabling quality sleep varies. Regulating the temperature in response to one's sleep state requires a sleep state estimation mechanism as well as a bed climate actuation mechanism. The *Comfy Fuzzies* mattress sleep state sensor and mattress topper facilitate a better night's sleep in comparison to a traditional bed by meeting the requirements of such a feature. In this overview, a new business venture is outlined that details the product and business development roadmap leading to a profitable business with an estimated 2000% return on initial capital investment in five years.

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Contents

1	Executive Summary	2
2	Problem	2
3	Solution	3
4	Technology	3
5	Market Validation	4
6	Focus and Adjacent markets	5
7	Market Size	5
8	Go-to-Market Strategy	6
9	Business Model	7
10	Financials	7
11	Team	8
12	Acknowledgments	8
	References	8

1. Executive Summary

- Good sleep is vital to Healthy life [1, 2]
- Poor temperature regulation contributes to poor sleep [3]
- Current consumer market solutions are expensive and collect low resolution data



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Figure 1. Problem

In 2013, the Centers for Disease Control and Prevention (CDC) declared sleeplessness a public health epidemic citing a correlation between unhealthy sleep patterns and chronic diseases such as diabetes, obesity, heart disease, depression and early death[1] [2]. According to Sleephealth.org 70% of adults report that they obtain insufficient sleep.

While there are multiple factors causing insomnia in adults the thermal environment is a key determinant of sleep because thermoregulation is strongly linked to the mechanism regulating sleep - our circadian rhymes[3] Thus if we can ensure the proper thermal environment throughout the sleep cycle we can significantly promote the quality of sleep.

While there are a lot of products on a market from sleep pills and sleep apnea machines to sophisticated bedding products claiming to lock human heat or cool during night, there is almost none, with an exception of very expensive "Eight Sleep", who claim the self regulation of mattress temperature throughout the night based on multiple sensors in the mattress.

What makes *Comfy Fuzzies* unique and attractive? *Comfy Fuzzies* is built on the principles of biofeedback. Having the sensors in the "sleeper" sock, the system receives the high resolution data about one's sleep data and quickly adjusts the bed environment to the required temperature that matches the ultimate state of the circadian rhythm at every given moment at night. The solution comes with an appealing bonus - it is half the price of the cheapest model from "Eight Sleep".

As one can imagine there are millions of Sleepless in America and in the world. We are starting from the most vulnerable and most impacted population - our elderly, that are over 50M only in US. The solution will be useful to **cancer patients** (who have difficulties maintaining their body temperature by themselves especially if they are treated by chemo or hormonal therapy), **diabetic patients with neuropathy complications** (it has been observed that keeping feet in warm temperature reduce neuropathy symptoms), menopause women with uncontrolled hot flashes, and pretty much anyone who wants to keep his bed comfortable for sleep throughout the night.

2. Problem

Meet Vlad (Yana's dad and Comfy Fuzzie's idea inspiration), one of 50M elderly who has been fighting a battle for a good night sleep for the last 30 years. He is on 2 sleeping pills, 1 anti-anxiety medication (for his sleep), gave up his sleep apnea breathing machine, went through hypnosis and cognitive therapy, and still can't sleep. He puts on several layers of clothes, turns on the heater next to his bed, and feels cold under several winter blankets. He gets up in the middle of the night to adjust the setting in the heater, and again spends hours trying to fall back asleep. He is diabetic and a cancer patient but nothing makes his life as miserable as his inability to get a good night sleep!







Figure 2. Vlad: our target customer

3. Solution

During a typical night's sleep, individuals go through several sleep cycles between lighter and deeper sleep. As one transition between these sleep states, the ideal temperature for restful sleep varies in correlation with the sleep state (cf. Figure 3).

There are existing products that feature unilateral climate control with either heating or cooling only, bilateral climate control with both heating and cooling, but none use high resolution sleep state estimation to dynamically respond to the user's sleep state. Instead, they rely on a temperature schedule which will not track the user's sleep state accurately. There are other product offerings that provide sleep state estimation, but do not connect to any bed climate control actuation mechanism so one is only informed of their sleep quality and what factors may have influenced it.



Figure 3. Illustration of an individual's optimal sleep temperature in relation to their sleep state.

The *Comfy Fuzzies* product is distinguished from the competition in that it provides bilateral bed climate control and uses a high fidelity sleep state estimation system to automatically adjust temperature with the user's sleep state.

4. Technology

The solution is realized in three subsystems. The first is a sensor unit for taking physiological measurements in real-time, the second is a statistical inference model for estimating sleep state based on a the recent physiological measurements. The temperature setting is then set based on the estimated sleep state. Lastly, a temperature actuated mattress topper is adjusted to the temperature setting selected by the inference and decision software. The signal flow diagram is llustrated in 4







Figure 4. Technology

Sensing In order to maximize the fidelity of sleep state estimate a sensor unit is placed in contact with the user's skin. The sensor unit consists of X distinct sensors. A thermistor is used to measure skin temperature alongside a heat flux sensor which measures the flow of heat through the skin. These two sensors together can be used to estimate not only the core body temperature, but the metabolic load of maintaining the current body temperature. An inertial sensor unit equipped with three axis accelerometer and gyros measures motion which can measure breathing rate and profile, heart rate, and general restlessness which can all go into a statistical inference model for estimating sleep state.

The sensor also has a battery pack and Bluetooth modem for wireless communication to an iOS or Android mobile device which is used to run the inference and decision making software.

Inference An inference model is generated from supervised data generated in a sleep study at a sleep clinic. The sensor unit is used to collect data alongside clinical sleep monitoring equipment to serve as ground truth sleep state measurements. This data set is then used to train the model that will rely solely on the *Comfy Fuzzies* sensor unit for sleep state estimation. The decision for the temperature is a set based on the current sleep state.

Actuation The temperature is regulated by a bedside heat pump which can be operated for heating and cooling. A temperature controlled fluid is pumped through flexible tubing sewn into the mattress topper. Heat from the air between the mattress topper and user's blanket is exchanged with the temperature regulated fluid to control the temperature in the bed.



Based on our market research, there is a \$28B sleep market and out of that around \$16B is a mattress market[4].

There are some products out there that have sold over 100K climate control beds as well as over 150k sleep tracking rings but none have provided bio-feedback to regulate the sleeping climate. There is another company named 8-night sleep which is upcoming to regulate the temperature of the bed but they do not have an option to collect feedback directly from the body of the sleepers. Comfy fuzzies did its market research and the feedback was overwhelming. Following are a few testimonials we have put here.

• "I'll do anything to have at least 5 hours of straight sleep (without waking up), but nothing I tried so far has worked for me" - Anatoly, 79 year old male from Oregon.





- "Nothing works, I've been struggling for years! I am on 3 anti-anxiety pills, 1 sleep pill, dumped the sleep machine as I couldn't breath normally through it, I tried hypnosis and meditation." Vlad, 81 year old male from California
- "Your idea sounds great, especially if insurance will reimburse some of the cost" 2 female residents of Lytton Gardens senior care facility, Palo Alto, CA

Based on existing products in this space and our market research, we concluded that there is an opportunity to introduce a comfy bed to enhance the sleep experience for these people struggling to get good essentials.

6. Focus and Adjacent markets



Figure 6. Focus and Adjacent markets

So how do we start and where do we focus? We feel that the Elderly market will be a great start. This is a photo from our CEO's dad who is constantly struggling to achieve optimal temp to have good night sleep thought out the night. Like him, there are over 50M people in this boat who can be benefited from Comfy fuzzies! But, there are more adjacent markets some are overlapping with the elderly group but others are not. These include Neuropathy diabetes and canceler patients, Menopause women who all can get benefited from our product.

7. Market Size

We estimate the focus and adjacent markets to be of 120 million sleepers in the US (50M elderly and around 80M adjacent populations - neuropathy, menopause and cancer). Within the first 5 years we expect to be able to penetrate 0.02% of our servicable available market (10% of 120 Million).

This translates to around 200K which is about the same number of devices currently in the market reported by chillipad and OURA ring - thus validating that this number is realistic.

To reach the 200K devices milestone, we will start a bootstrap phase during which 1.5K devices will be built and shipped to elderly adults in care facilities. We expect to reach the 1.5K milestone around year 2.

From years 2 to 5 we will gradually ramp up production to 200K and build our dataset of high resolution, rich feature set of sleep data. This dataset will be one of a kind, allowing us to tackle the insomnia epidemic using unique insight and approach. We believe that this unique business advantage will allow us to penetrate 10% of the sleep market starting from year 5.







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During our bootstrap phase, we will run a pilot program in one of Florida or San Jose based elderly care having 200-300 beds. We called Sunrise in San Jose to gauge the interest and they were interested in such a product. It will be free of cost to them and we will bear the cost. After validation and fine-tuning of the product and corresponding software, we will enter into the growth phase to expand within US elderly care facilities and senior villages across all states. During the growth phase, we will invest more in business market personnel visiting these facilities with the product and conducting live demos.

Finally, while we continue to expand nationwide, we will be ready to enter into adjacent markets. During this phase, we will not only focus on the elderly market but also on diabetic, cancer patients, and menopause women. With the strong presence in the elderly care facilities along with testimonials/reviews and financials, we will open dialogue with big-box retailers such as Walmart and Target to start putting the product in their selected stores.





9. Business Model 0

We make money by selling the hardware at \$750 and charge \$60 for the subscription to the sleep monitoring and regulating application.

The hardware we sell for bootstrap phase is existing Ooler sleep mattress cover currently MSRP for \$650 and custom sensor kit that we can manufacture for \$50. Our MSRP for the whole solution will be \$750.

Other alternatives that exist in the market include the eight mattress that MSRPs for \$3000. However, the measurements collected will not be as accurate. A more accurate measurement could be provided by visiting an in center sleep study, which costs \$500-\$3000 and is a single event.

Our gross profit will be \$50 at time of purchase and \$60 yearly for continuous data collection and sleep tempertature regulation. Over the course of 5 years, we expect to generate \$40M gross profit from both revenue streams.

10. Financials

We generate 2 revenue streams per-item:

- \$710 device purchase (sell price)
- \$60 app subscription

Our fixed costs from month 6 to 24 include:

- core team salaries \$800K
- Hardware \$160K
- Advising costs \$40K

Our variable cost per-item are:

- Manufacture cost \$50
- Off the shelf hardware cost \$600

Plugging these into the Cost-Volume-Profit model, we get the projections in table 1. We expect to become profitable between years 2 and 3.





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	Year One	Year Two	Year Three	Year Four	Year Five
Devices Sold	200	1,500	24,500	63,200	190,200
Revenue	\$0K	\$1.2M	\$19.9M	\$52.7M	\$159.4M
Gross Profit	\$0K	\$165K	\$2.8M	\$8.5M	\$26.2M
Gross Margin	N/A	13.58%	13.97%	16.14%	16.48%
Fixed Costs	\$500K	\$1M	\$1.5M	\$2M	\$2.5M
Net Profit (Pre-tax)	-\$500K	-\$835K	\$1.3M	\$6.5M	\$23.7M

Table 1. Financial projection - Years 1-5

11. Team



Yana Doctorov CEO Yana has 30 years of experience building and shipping enterprise IT products as well as nursing and caregiver experience



Brian Paden CTO Brian holds a PhD in robotics from MIT and has extensive experience in mechatronics and automation.



Santosh Pathak CMO Santosh holds a MS in Computer Science and post graduate diploma in

hation. business management with specialization in marketing and sales promotion. Figure 10. Comfy Fuzzies Team



Ronen Vaisenberg CFO Ronen has a PhD in CS from UC Irvine and over a decade of navigating product uncertainty to create value for billions of users around the world.

12. Acknowledgments

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References

- [1] Mary Amanda Dew, Carolyn C Hoch, Daniel J Buysse, Timothy H Monk, Amy E Begley, Patricia R Houck, Martica Hall, David J Kupfer, and Charles F Reynolds III. Healthy older adults' sleep predicts all-cause mortality at 4 to 19 years of follow-up. *Psychosomatic medicine*, 65(1):63–73, 2003.
- [2] K Manabe, T Matsui, M Yamaya, T Sato-Nakagawa, N Okamura, H Arai, and Hidetada Sasaki. Sleep patterns and mortality among elderly patients in a geriatric hospital. *Gerontology*, 46(6):318–322, 2000.
- [3] Saul S Gilbert, Cameron J van den Heuvel, Sally A Ferguson, and Drew Dawson. Thermoregulation as a sleep signalling system. *Sleep medicine reviews*, 8(2):81–93, 2004.
- ^[4] John LaRosa. Top 6 Things to Know About the \$28 Billion Sleep Market, 2018 (accessed Dec, 2020).



