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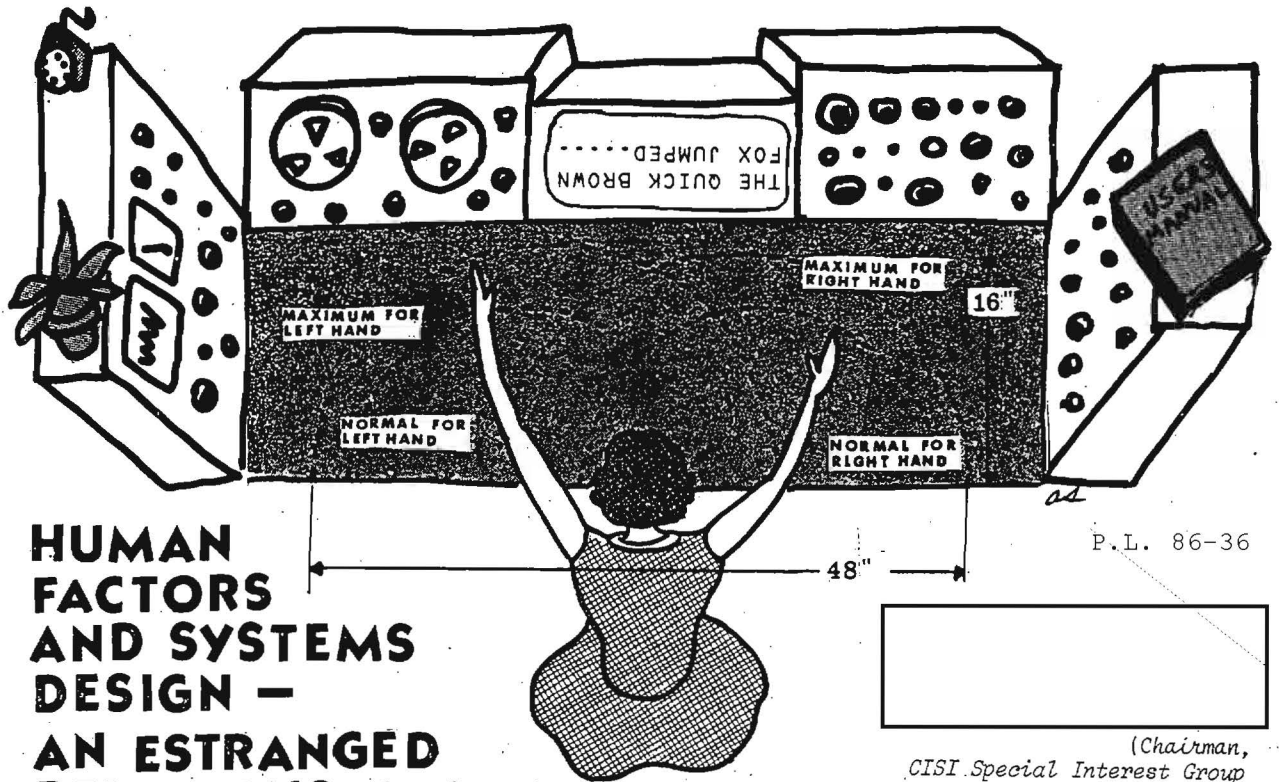
HUMAN FACTORS AND SYSTEMS DESIGN — AN ESTRANGED RELATIONSHIP?

*(Chairman,
CISI Special Interest Group
on Human Factors)*

The process of designing computer systems -- particularly, on-line interactive display systems -- in today's environment presents challenges that summon the very best from a variety of professional disciplines. Those who have survived the experience of specifying, designing, and implementing such systems will no doubt agree that the most difficult task can be that of analyzing and providing useful, viable solutions to problems of the man-machine interface.

In a total systems context, man-machine interfaces are rarely simple. Environmental factors -- such as visual problems caused by glare or distracting reflections, awkward positioning of keyboards and control devices, uncomfortable consoles with sharp edges, lack of storage or writing space, exhaust fans blowing hot air on the operator and causing normal eyes to dry out and eyes with contact lenses to become seriously irritated, etc. -- present a set of problems in themselves. Generally speaking, the "man" part of the system in terms of physical dimensions, visual and auditory sensory systems, sensitivity to heat, cold, noise, vibration, and other environmental factors have been well documented. Knowledge of these is fundamental to systems design and should be part of the skills the professional has acquired through formal courses or independent study. There is simply no excuse for overlooking human physiological characteristics, or basic needs and comforts, when hardware is being designed. But, unfortunately, these are indeed ignored

with alarming regularity, and, by the time the end-user discovers what has been done to him, it is usually too late to change. Talk to field station personnel sometime! They could write a book on equipment horror stories.

The man-machine design task is compounded by another set of problems brought on by the complexities of having a human being function as a major working component of the system. The human component, while intelligent, adaptive, clever, and resourceful, is also characterized by serious processing limitations, individual differences, and unpredictable -- sometimes illogical -- behavior. The seemingly infinite number of problems introduced by the human element call for special knowledge and skills. Systems analysts/designers must look to the human-factors profession and related fields (psychology, for example) for guidance. Specifically, it may be desirable to seek direct assistance from human-factors specialists. Since such specialists are not readily available, especially at NSA, an alternative is to research human-factors literature. The latter alternative is difficult and should be approached with caution, respect, and a dash of wisdom. Over the past several years, I have probed the journals and technical papers issued by human-factors societies, searching for answers to a variety of questions. The sobering fact is that such searches have typically yielded little information that could be applied to the real world.

Most laboratory experiments conducted by psychologists (even those boasting of being "applied psychologists") have very limited relevance to practical problems. Lab experiments can select only a few independent variables, and unsuspected interactions in more complex real-life conditions may nullify or reverse conclusions reached in the lab. Only with extreme caution can one generalize from the results of such experiments. This is not to say that experiments cannot be of value. Some very significant work has begun in recent years in the computer industry, the military services, and in major universities in the United States and Europe. Basic studies in the areas of the effects of computer response times on users, display formats, the effectiveness of control devices (light pens, joy sticks, etc.) and techniques for imbedding training subsystems into basic software packages are a few examples. All show promise of helping systems designers.

Sparse as it may be, however, the information that is available contributes to a designer's general store of knowledge brought to bear on real-world problems. Beyond this, designers are pretty much on their own. At this juncture, it seems to me that the most reasonable course of action for the designer is to get down to the basics -- simple, accurate statements of problems in plain English, and commonsense solutions. This means long chats with the end-user of the system to find out what he *really* needs to do his job. It also means reviews (formal and informal) at many points in the system-development process, with strong user participation.

From the very beginning, the user must become actively involved if there is any hope of influencing the system that will show up at the door some day. Systems designers, being finite creatures, can go only so far in interpreting what the user really needs and how the analyst's mental processes might function in the heat of problem-solving.

Much can be done to provide highly responsive generalized system capabilities that will satisfy most of the users most of the time. But where in the system is the point reached where specialized capabilities tailored to critical or frequently executed processes are necessary or justified? What are the most meaningful ways to organize and present data to the analyst? Are traditional manual ways of working the best ways in an interactive computer environment, or is a whole new concept needed? How fast must the system respond to user requests for information? What is the response threshold beyond which user productivity is significantly reduced or problem-solving abilities are rendered ineffective because human short-term memory is disrupted? Many such hard questions must be asked and alternatives must be probed. Systems people and users must rigorously analyze specific tasks, information needs, and work scenarios to identify and specify needed capabilities. It all takes time and a lot of hard work. There is no short cut. If it is done right, the dividends are high.

If there is any conclusion to be drawn from these mental meanderings on the very diverse subject of human factors, I believe it is that, overall, there exists a serious gap between designers and end-users, and human factors are considered either "too little or too late." Closing the gap is a two-way process. Users and designers must both take active, positive steps toward understanding each other's roles in systems development and work closely toward a common objective. The objective should be to deliver useful, productive information-handling tools that take maximum advantage of what computers do best and what people do best, and that bring people and data together with the least resistance and highest productivity.

(UNCLASSIFIED)

Cheap CRT displays usually mean cheap character fonts. By saving a few bucks, you may be buying high error rates and lowering productivity.

On the low end of the CRT display scale are those El-Cheapo display terminals that draw characters with a 5 x 7 dot matrix. There is just so much you can squeeze out of that matrix: A through Z (capitals only), zero through 9, and a few awkwardly shaped special characters. The whole scene is rather barbaric!

Nevertheless, if your budget is low and your application limited, you may just end up with those kinds of CRTs in front of your analysts (or whoever). Faced with the 5 x 7 option, at least you should be aware of which character sets

offered by manufacturers are acceptable from a human engineering standpoint.

Human factors studies have shown three fonts to be superior. These are: Maximum Dot, Maximum Angle, and Lincoln/Mitre. Even the "best" of these (Maximum Dot) has a high percentage of confusion (25%) between certain characters (M, Q, S, U, V, 0, 1, 2, 7, and 8). If your application cannot tolerate this degradation, you should consider a better display terminal with a 7 x 9 dot matrix or even stroke-generated character sets. If you'd like to borrow the referenced studies, call me on 3758s.

(U)

OLD RUSSIAN MANUSCRIPT CIPHERS

In the CLA announcement on page ___ of the May issue of CRYPTOLOG, you probably figured out the way that dots and lines equate to numbers in the Maya writing system -- 12 is represented by two lines having a value of 5 each, plus two dots. The following article describes how a similar system of dots and lines was used in ancient Russia to represent not only numbers, but also something else.

Ed.

Translator's note: The following is a translation of an article by V. N. Perets, "Litoreya," in the prerevolutionary Russian *Ehntsiklopedicheskij slovar'* (Encyclopedic Dictionary), by Brockhaus and Efron (St. Petersburg, 1896, Vol. XVIIa, pp. 834-835). A current dictionary defines "litoreya" as "one of the oldest forms of secret writing, which is based on substituting letters of the alphabet for each other."

LITOREYA (from [Latin] "littera), secret writing system, type of enciphered writing used in ancient Russian manuscript literature. Two types of "litoreya" are known: simple [*prostaya*] and complex [*mudraya*]. The simple type, also called gibberish language, lies in the following. The consonants [in the *Russian* alphabetic order] are arranged in two rows [boustrophedonically]:

б в г д ж з к л м н
щ ш ч ц х ф т с р п

When writing the message, the letters in the upper row are replaced by the lower ones, and vice versa; the vowels remain unchanged. For example, лсошарь [sic] = словарь, etc.

Less well known, and less frequently used because of its complexity, is the complex type, the key to which lies in the following: the letters in the *Church Slavic* alphabet which have numerical value were designated by dots, lines, and circles. The values 1 through 10 were designated by dots:

a в г д е Ѕ з и Ѳ i

The values 20 through 90 were designated by horizontal lines:

к л м н ξ о п ч

And the values 100 through 900 were designated by circles:

р с т у ф х ψ ω ц

The following letters were not used to designate numbers: б, ж, ъ, ь, ы, ю, я. They remained in place unchanged. Thus, the word словарь written in complex "litoreya" would look like this:

By using this type of secret writing, a person could either create a riddle for his reader, or express his opinion in a manner that protected him from persecution; for example, in a certain ancient Russian manuscript we read the following, which was written in the complex type of "litoreya": "Andrej at the Romanov [monastery] is a knave, and I know that he's a knave; all you priests are thieves." See Vostokov, *Opis. rukop. muzeuma* (1842) and also his *Filologicheskiya nablyudeniya* (1865).
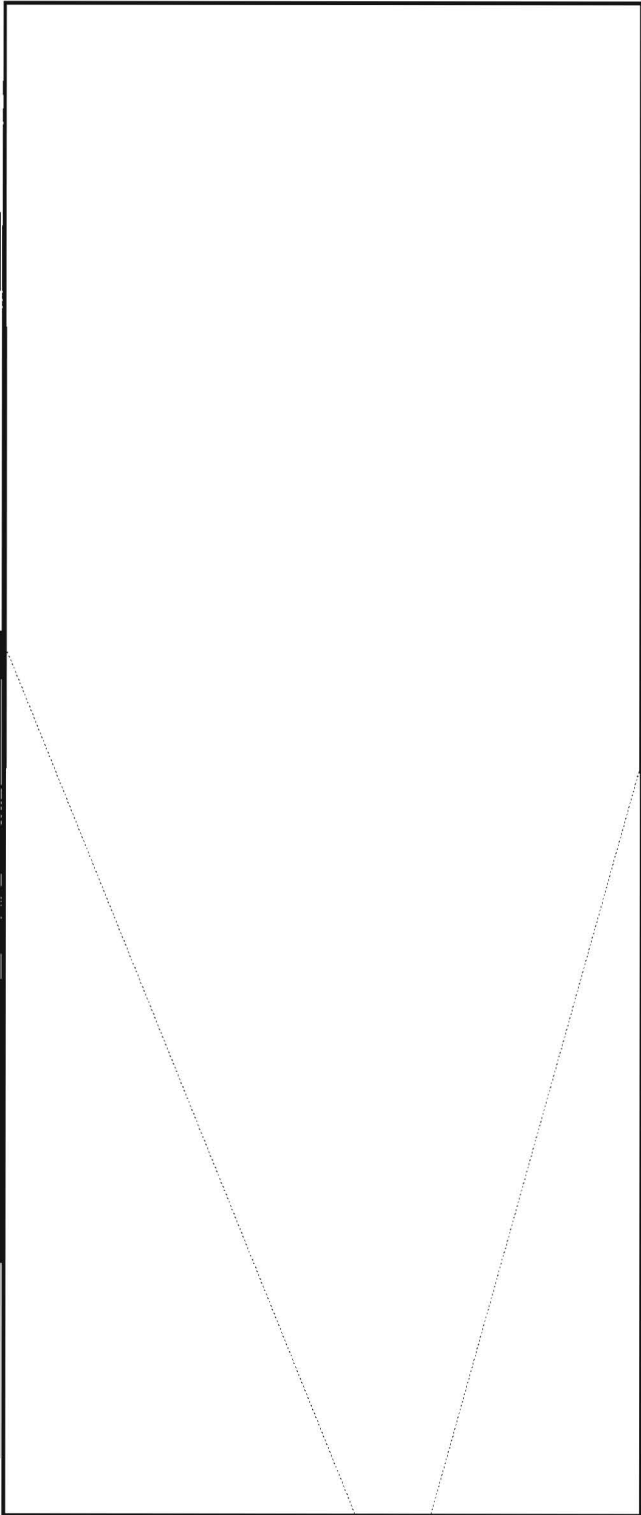
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SIGINT WELCOMES •INK• STAND

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The intelligence community has come a long way since the days of six-ply paper, MC-88 mills, headsets, and grease pencils in meeting its intelligence objectives. Automated systems now command the field in the collection, processing, displaying, reporting, storing, and management of SIGINT. Systems have been developed that are capable of identifying and exploiting

Each system was developed to contribute to the advance warning of the hostile military "threat" to the United States. We have seen these "project" systems developed, named, *re*developed, *re*named, and then we have seen them meet expectations or, having failed to meet them, be phased out. Yet, through all this, many of us who have had personal contact with these systems have come to cherish them as an exciting experience to be remembered.

There is another automated system in the works which may cause many an old S&WC analyst or reporter to wish it had come along sooner. This new system is known as Project INKSTAND

[1]See: [   ] "IRONHORSE: A Tactical SIGINT System," *CRYPTOLOG*, October 1975.
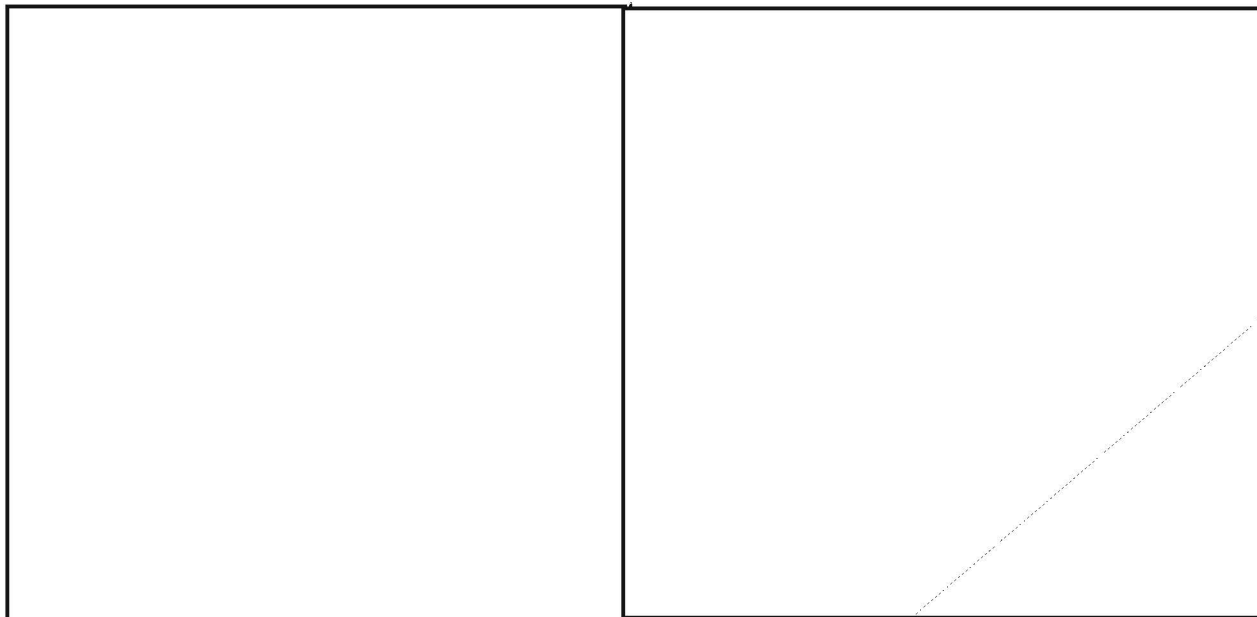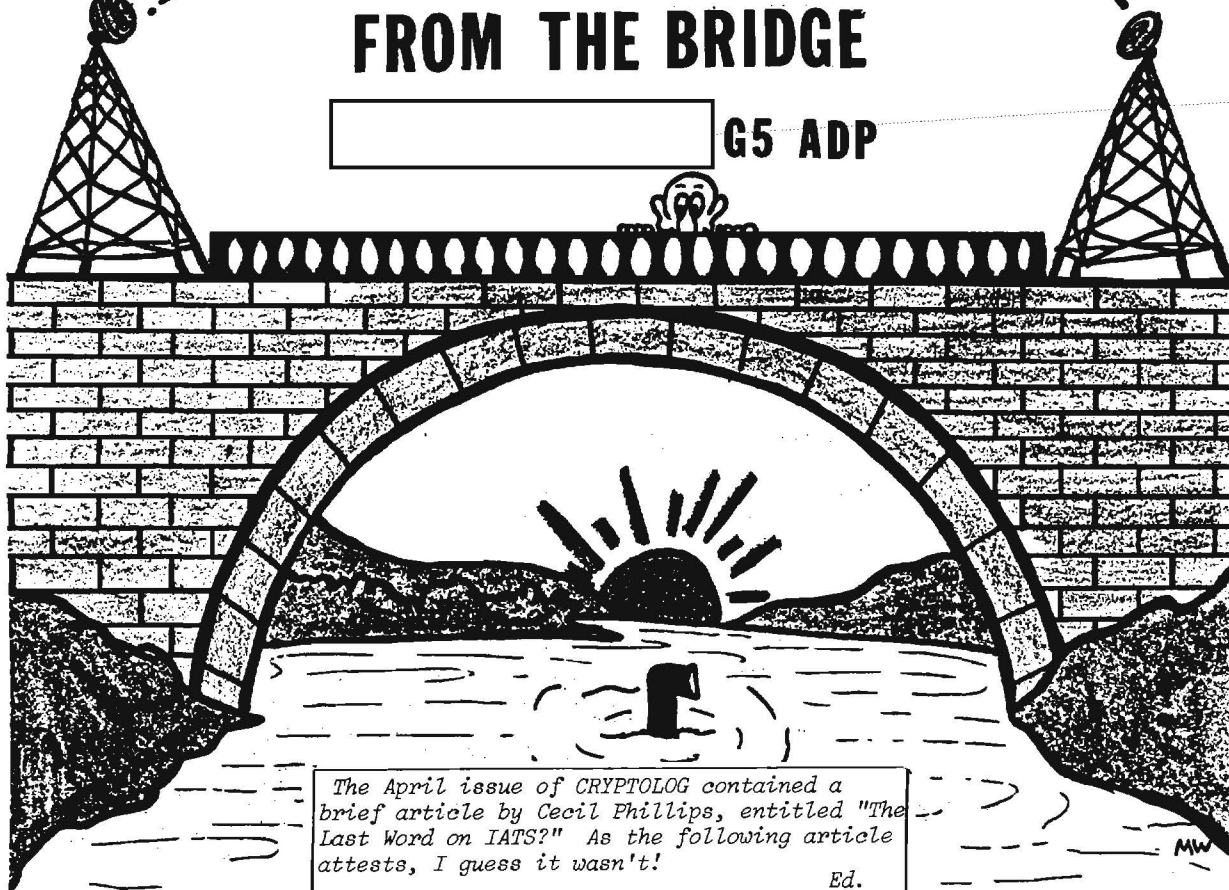
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AG22/IATS

A VIEW FROM THE BRIDGE

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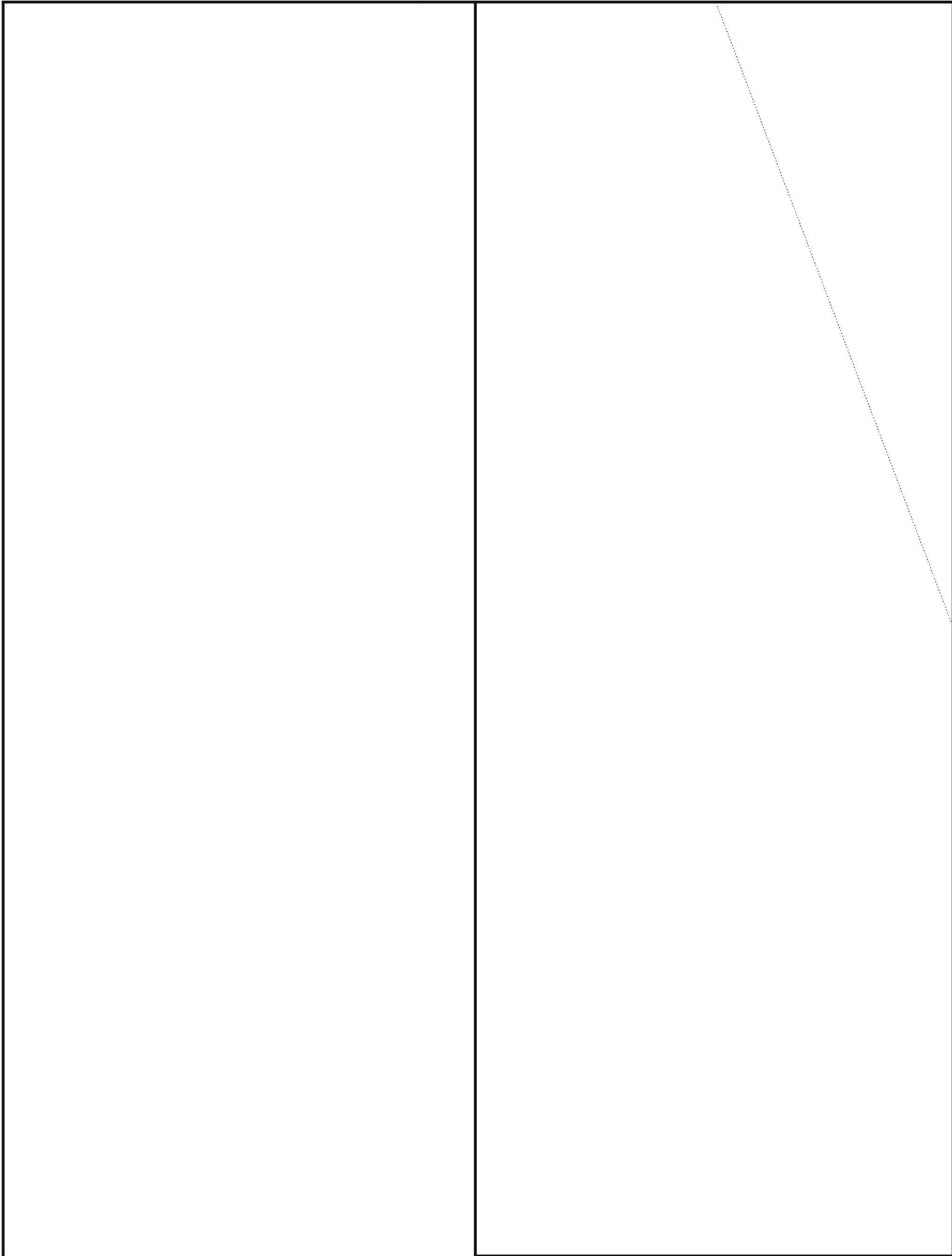
> The April issue of CRYPTOLOG contained a brief article by Cecil Phillips, entitled "The Last Word on IATS?" As the following article attests, I guess it wasn't!
>
> Ed.

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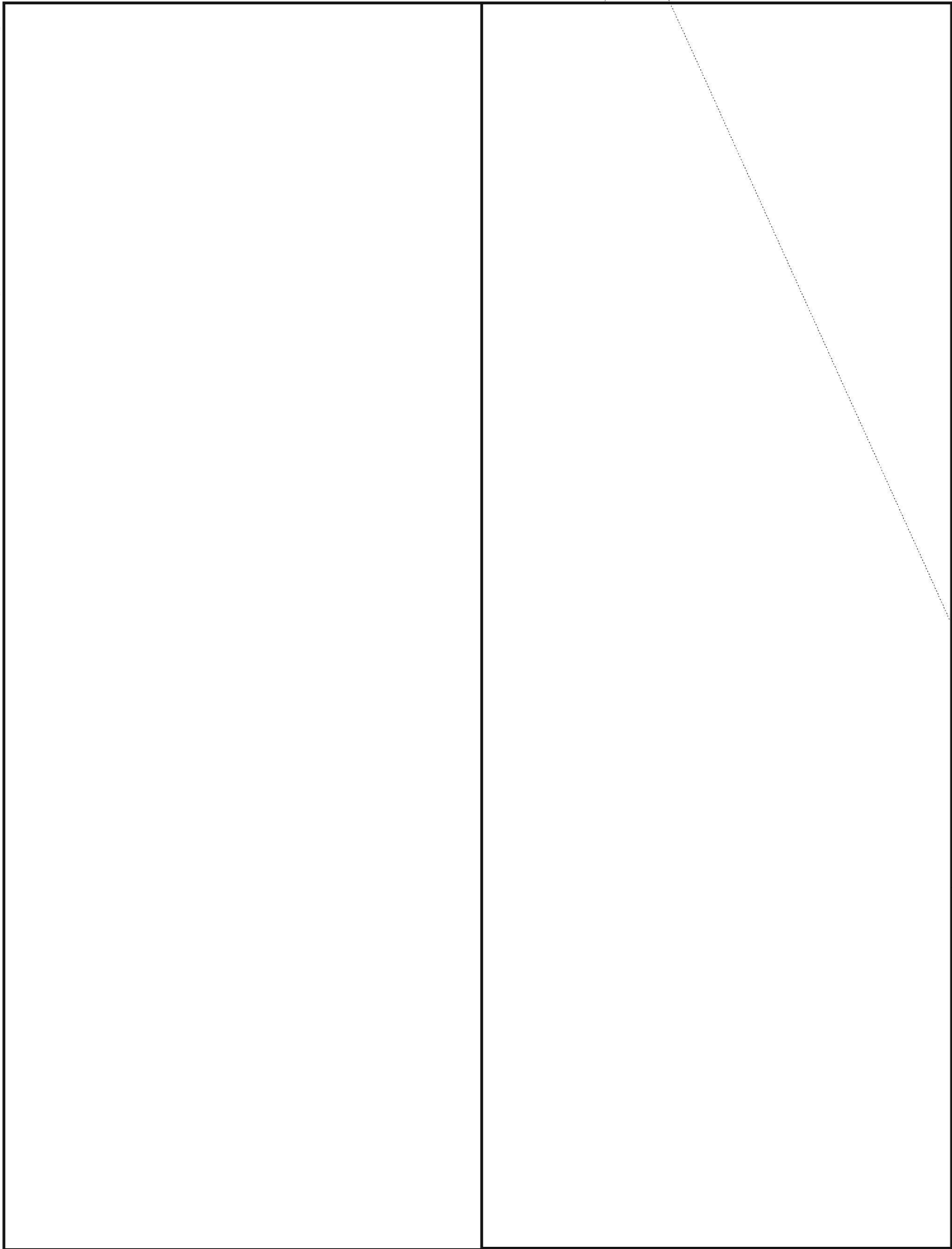
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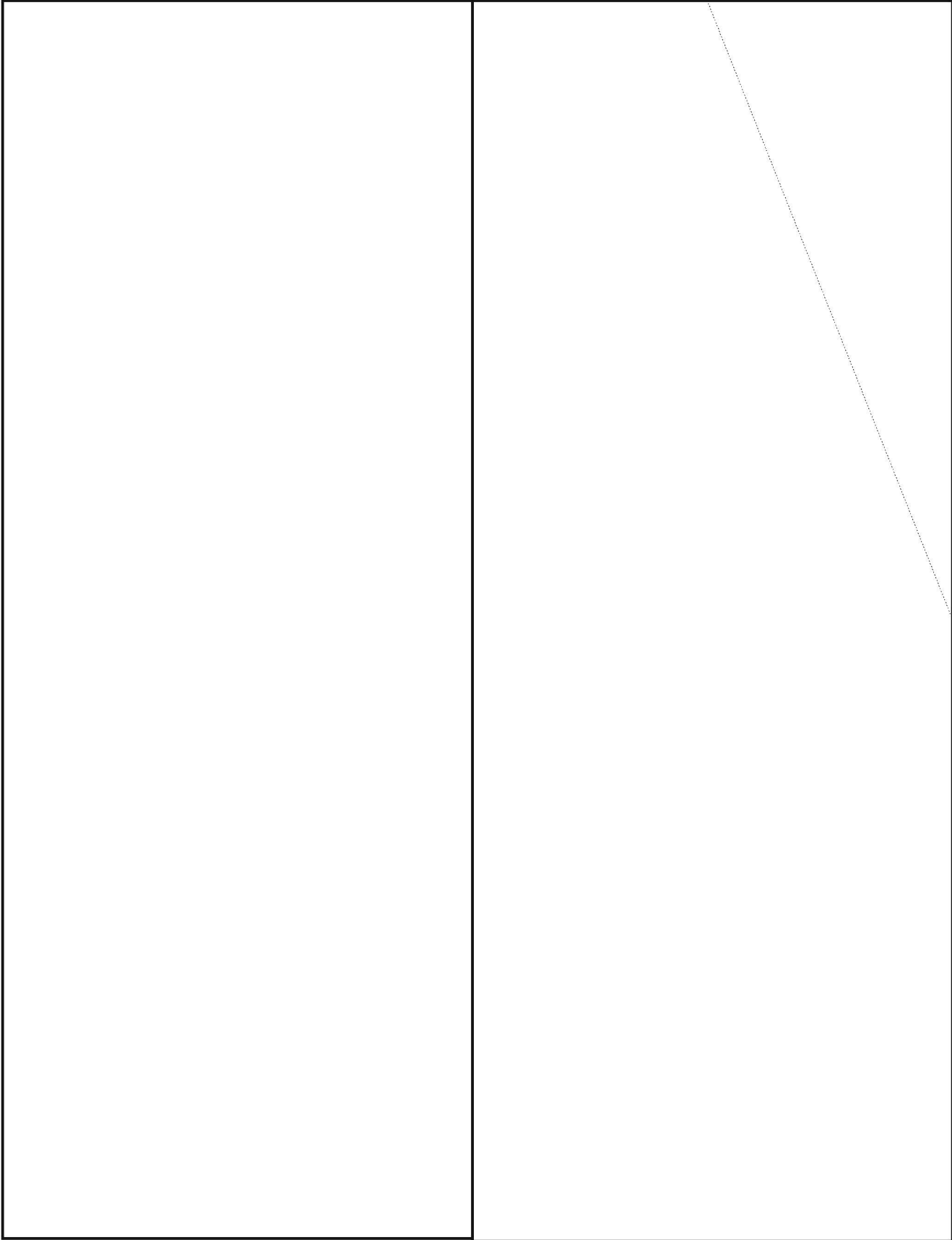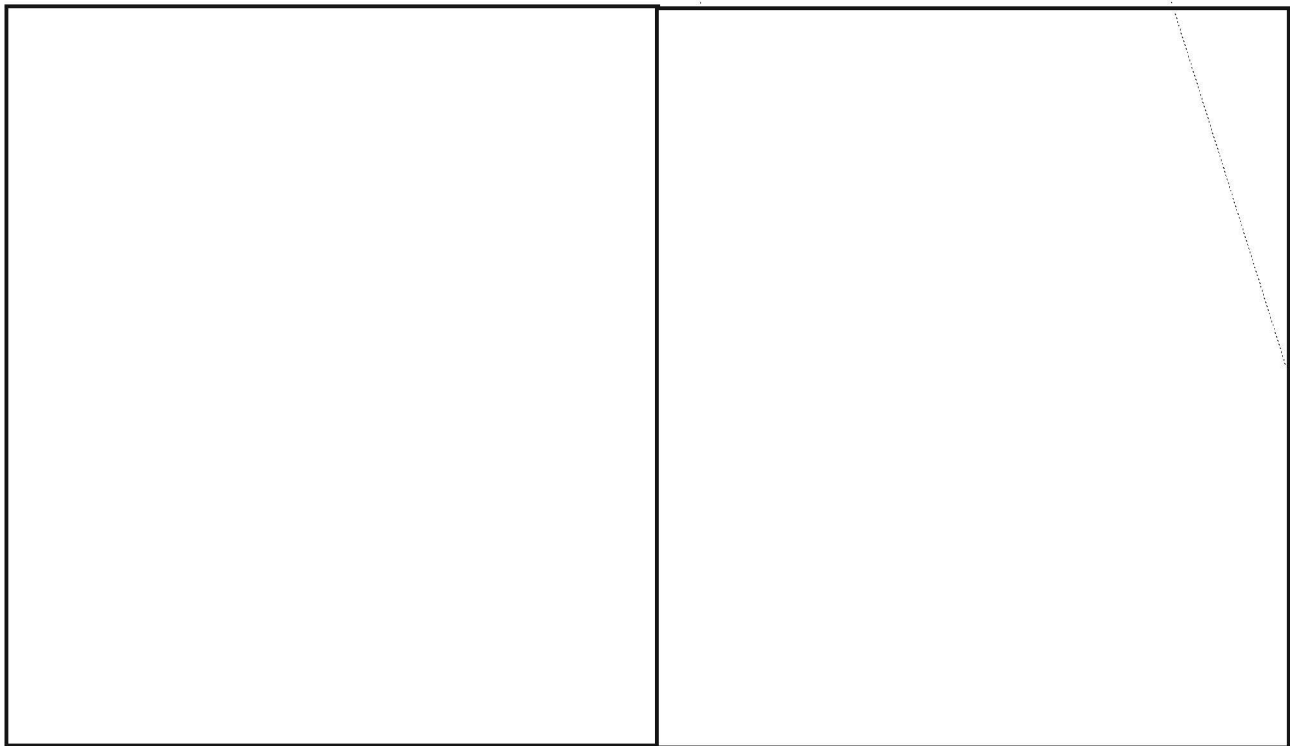SECRET SPOKE
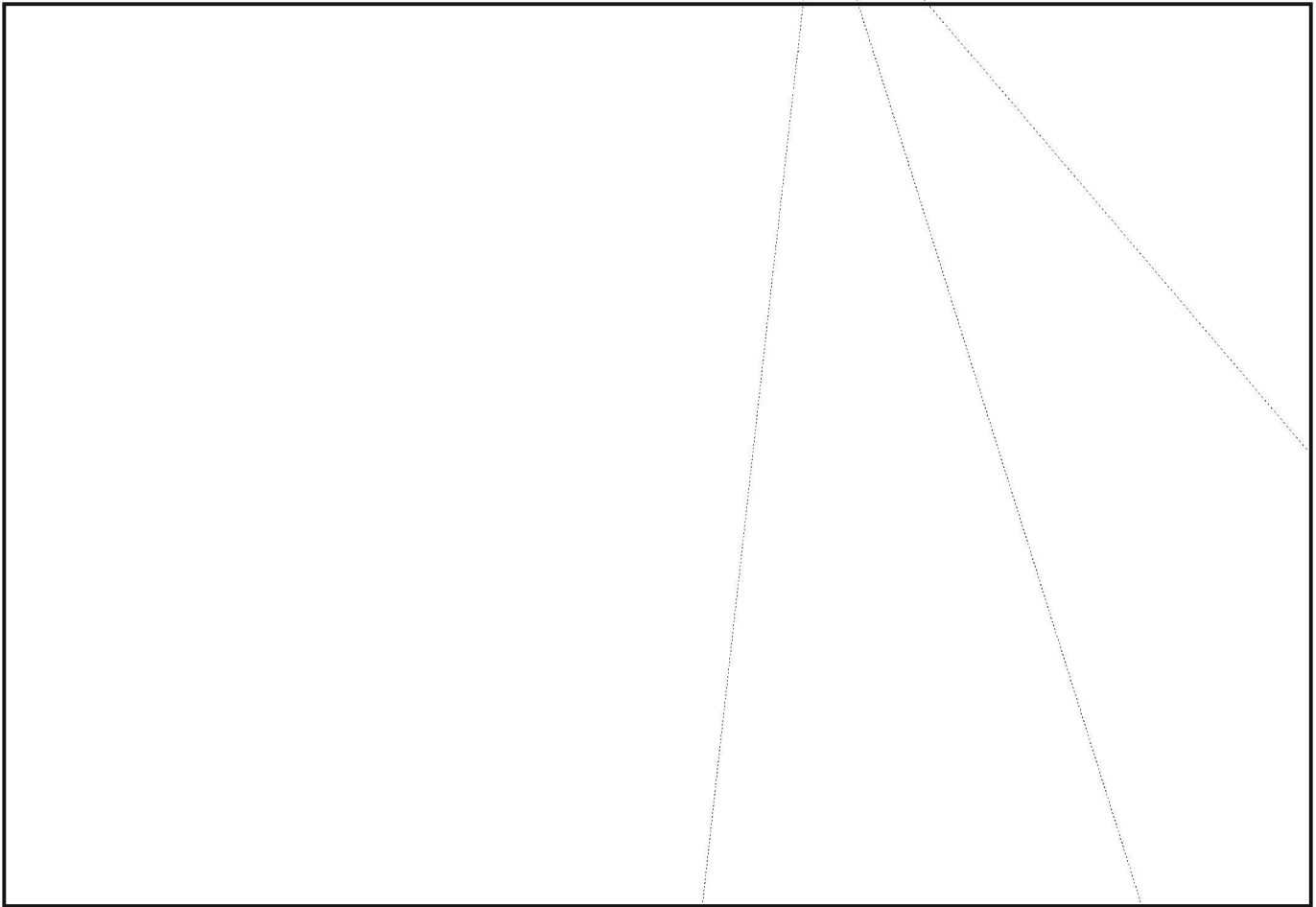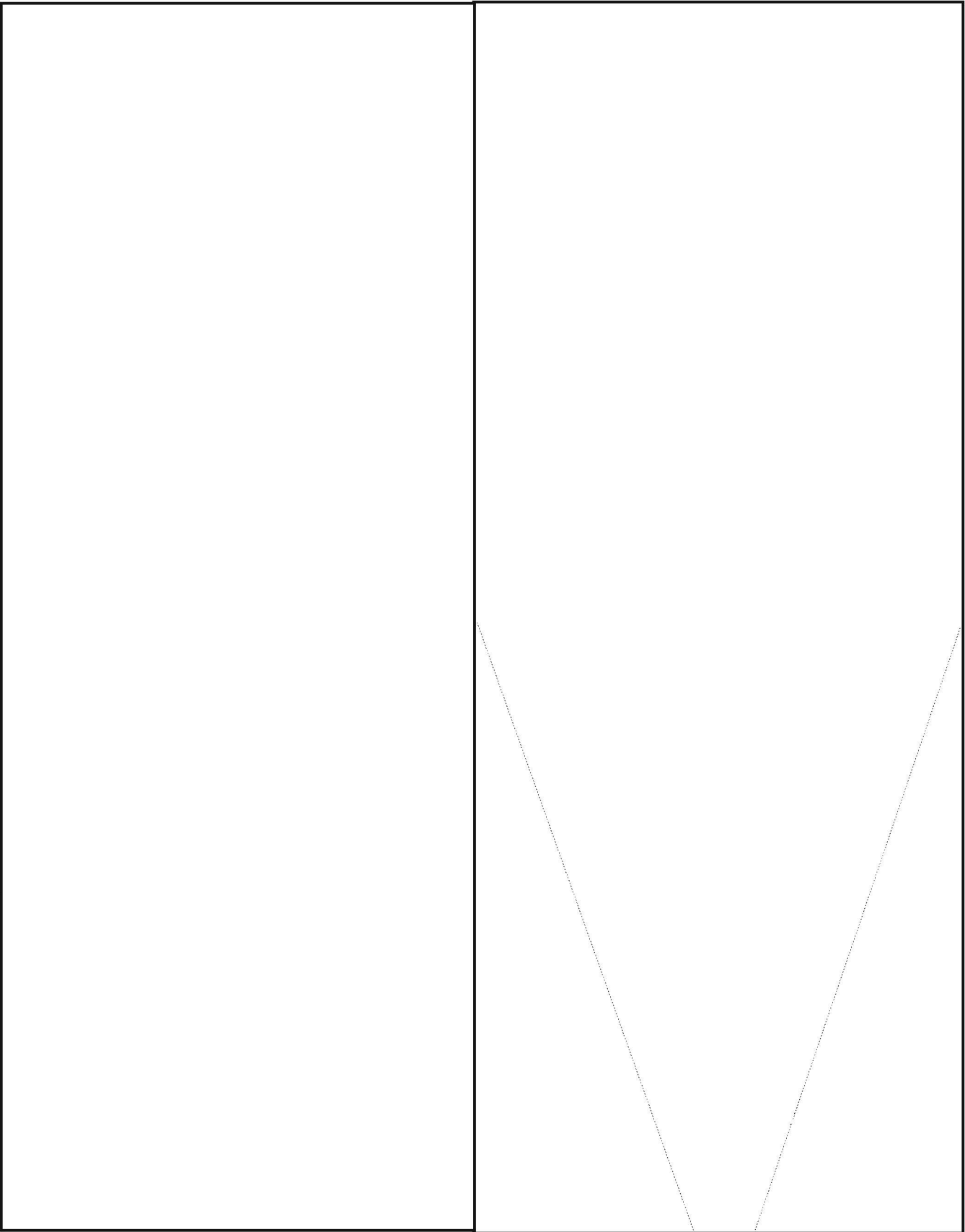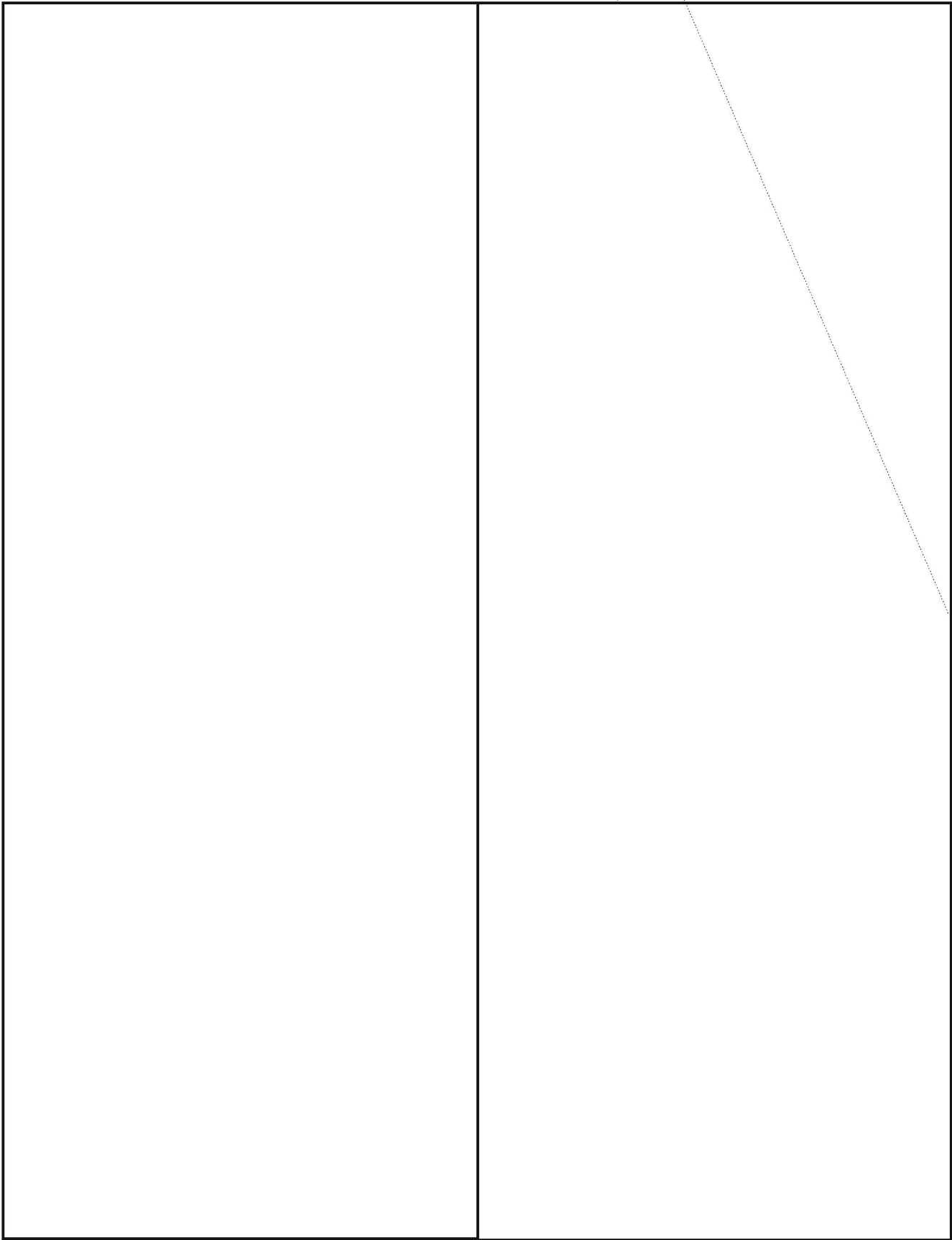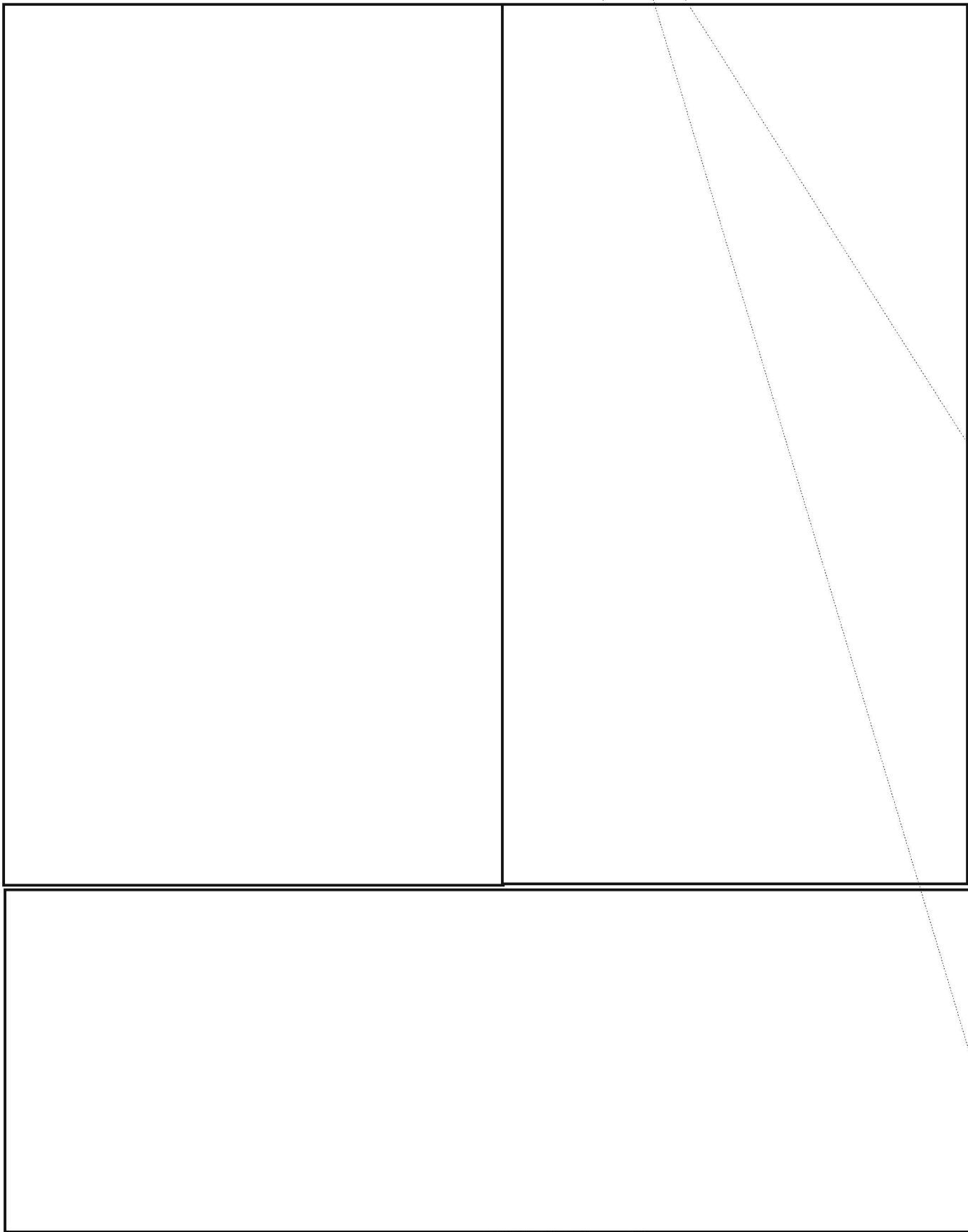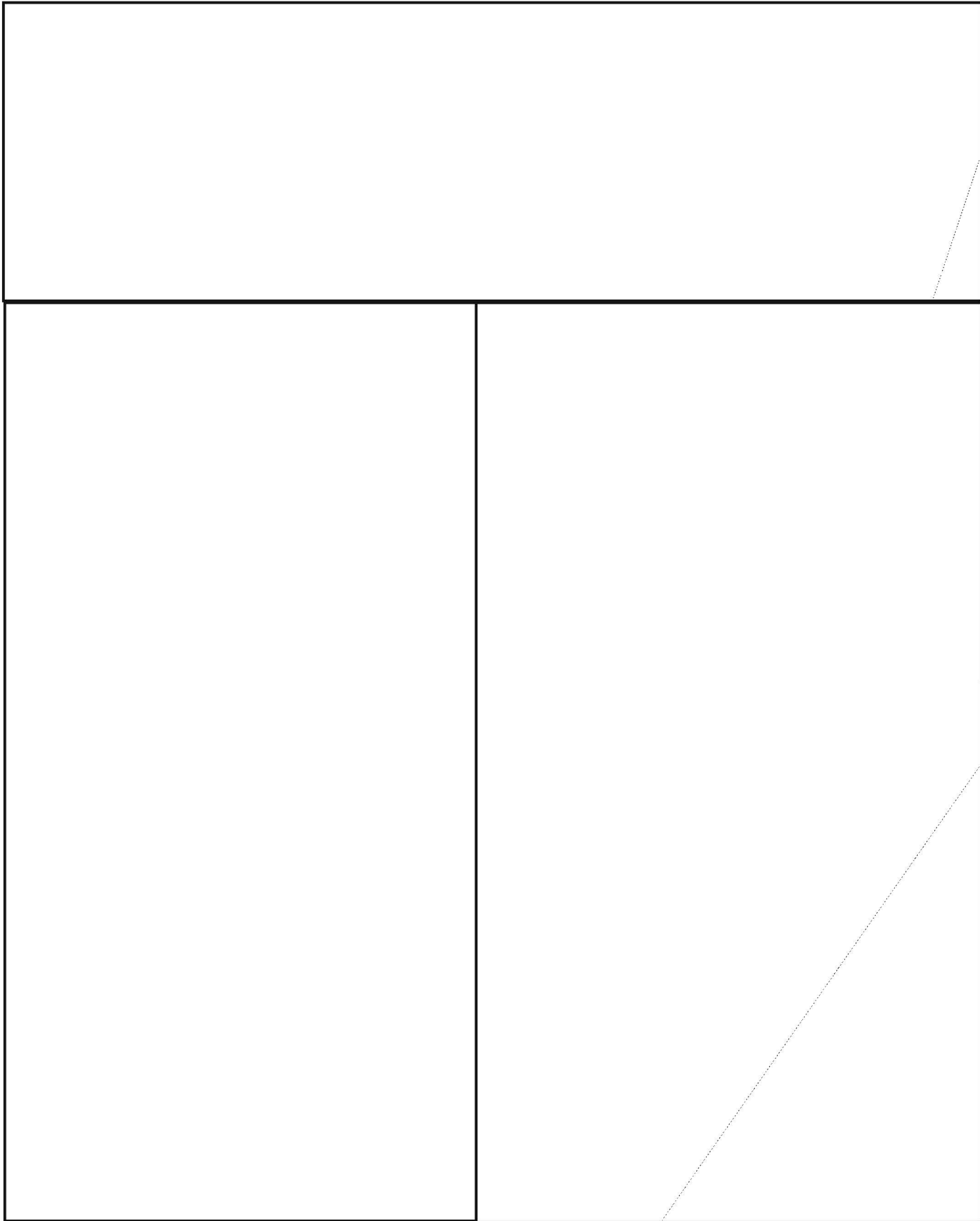
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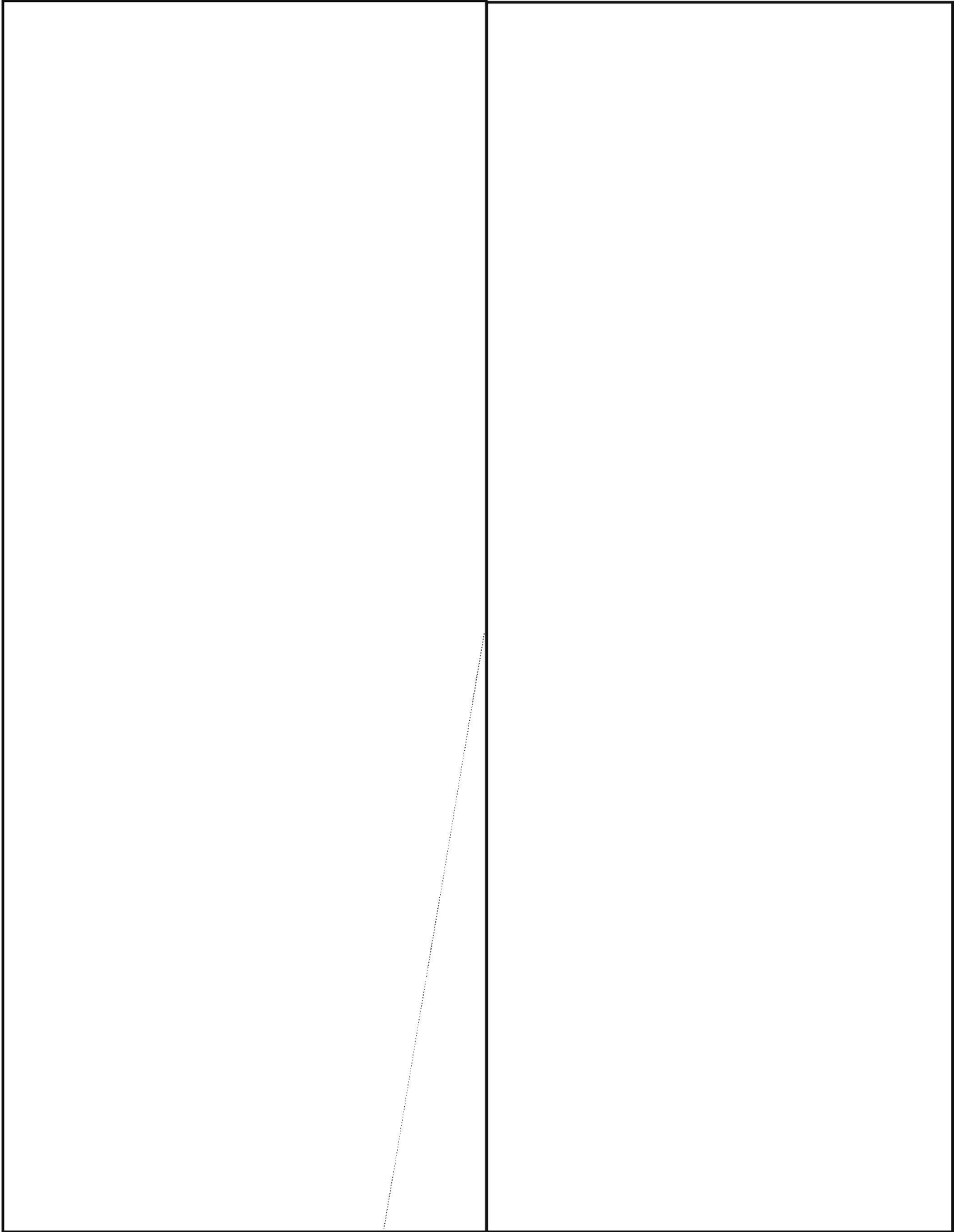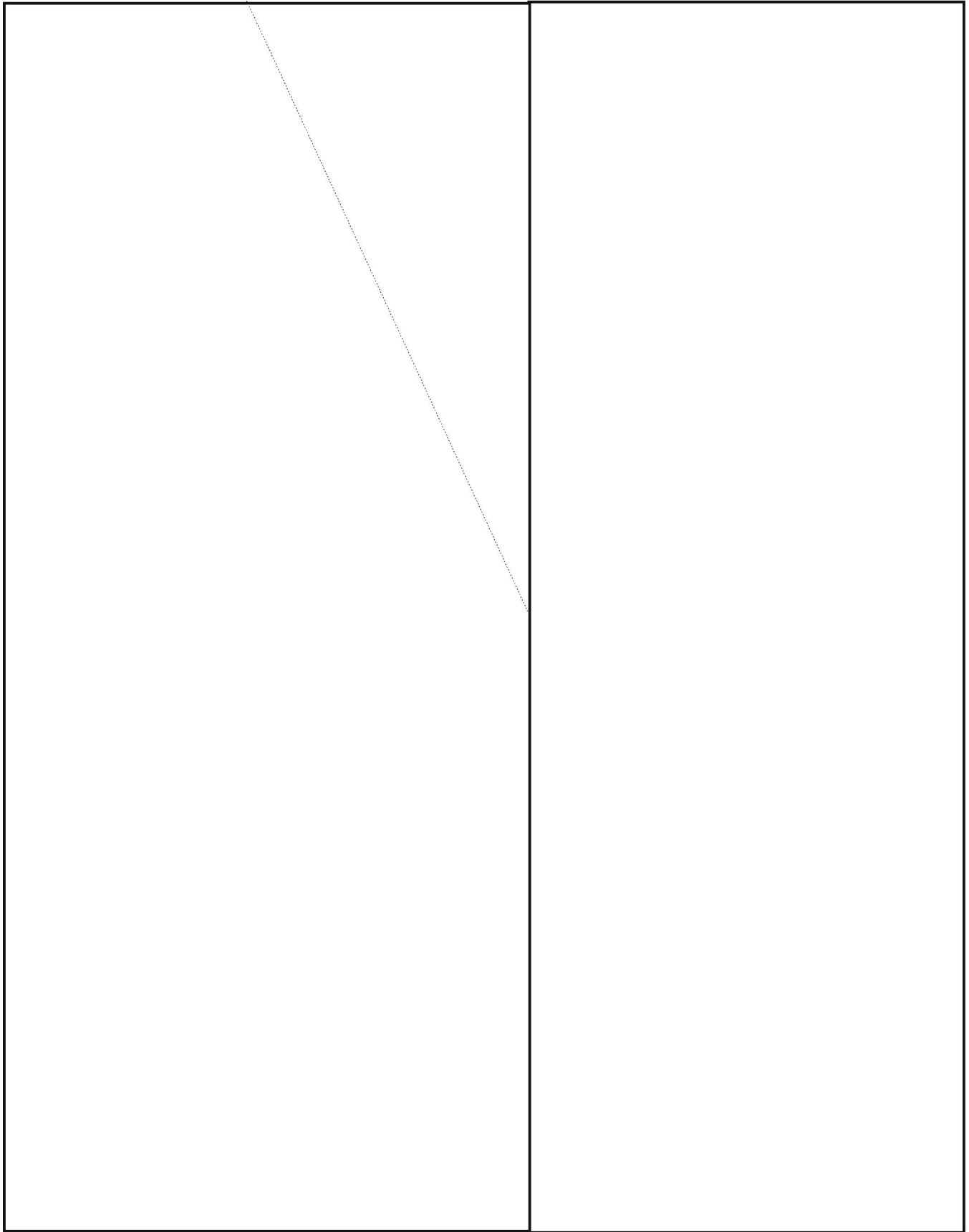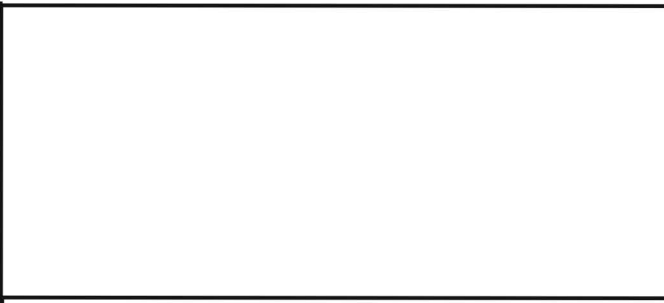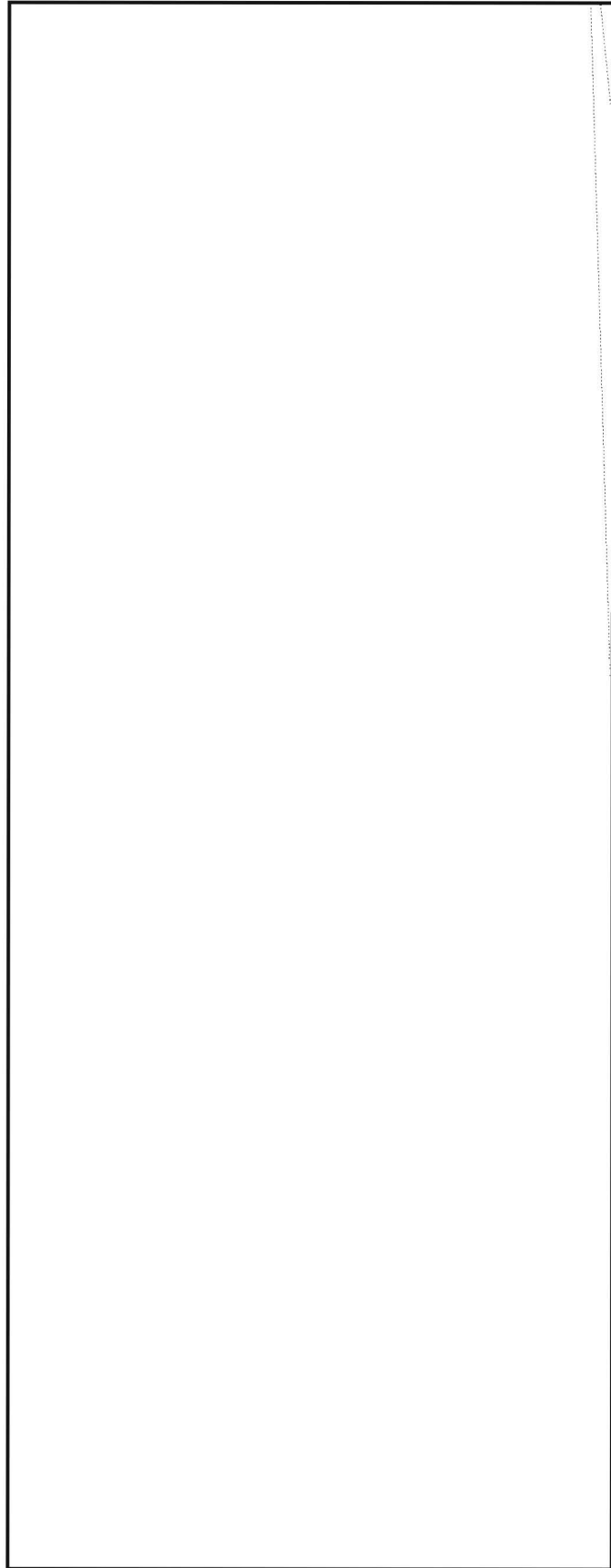
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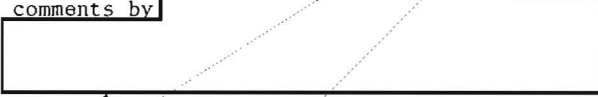
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Remember the old joke about the kid's book report? -- "This book told me more about penguins than I care to know."

Yes, and a lot of CRYPTOLOG readers might say the same thing about this article on AG-22/IATS.

Not me! I'm going to pull the whole article out of the middle of the magazine and save it!

VICH ISS R-R-RIGHT?
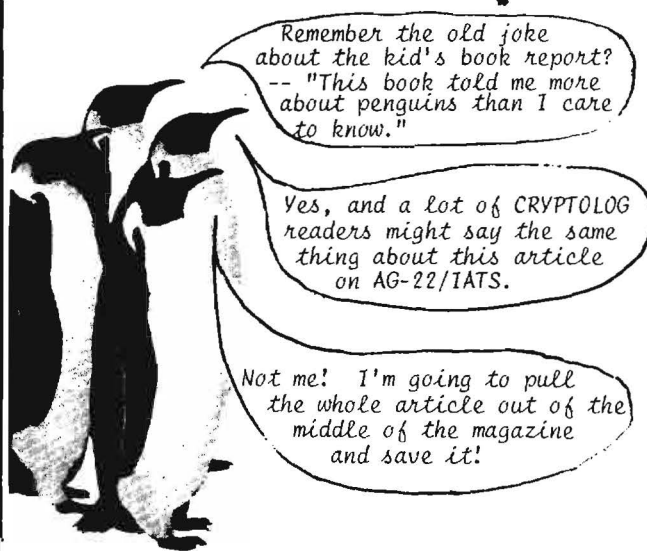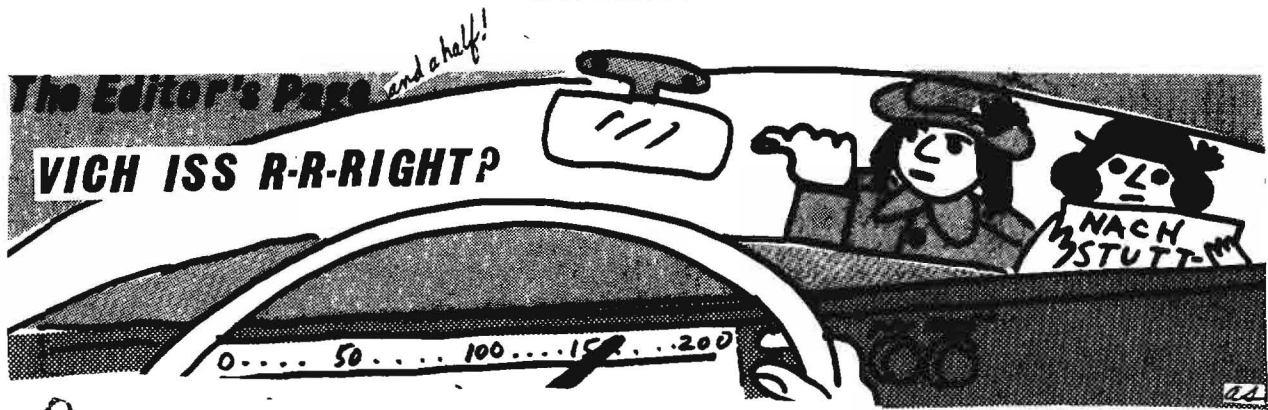
$\mathcal{S}$everal years ago a friend and I were chit-chatting when another person whom he knew joined the group. After introductions, the three of us carried on some more light banter, during which I noted a quizzical expression on the new person's face several times. The next day my friend told me that, after I left, his friend had said, "You know, for a linguist, that Mr. Salemme really uses atrocious grammar." "Like what?" "Well, he kept saying, 'Don't that beat all!' and 'Ain't that the truth!'"

Well, lately I've been noticing the same expression on people's faces when I used the word *kilo*meter, and I've decided that it's not quizzical but pitying. People used to come right out and say, "The correct pronunciation of the word is ki*lo*meter!" We'd fight about it from various angles, with me contributing wisdom and reasonableness and my opponent contributing non sequiturs like, "But it's ki*lo*metro in Spanish. . ." Then we'd retire to neutral corners and each feel good about being right. But now people just put that pitying look on their faces and don't want to talk about it. So, since I can't defend myself face to face, I'd like to use this means of putting into written form (*Congressional Record* please copy) my views on the *kilo*meter vs. ki*lo*meter controversy.

If language were logical. . .

If language were logical, I'd use the following argument. I'd break the word kilometer into two components. I'd say that in every word with the combining form "kilo-" (meaning "thousand units" in the metric system), the main stress is always on the first syllable (with a secondary stress on the second component of the word). These words include:

*kilo*ampere	*kilo*gauss	*kilo*parsec
*kilo*bar	*kilo*gram	*kilo*ton
*kilo*buck	*kilo*hertz	*kilo*var
*kilo*calorie	*kilo*joule	*kilo*volt
*kilo*cycle	*kilo*liter	*kilo*watt

Then I'd say that the English words ending in "-meter" fall into three separate and distinct categories according to meaning. They are:

- units of poetic meter (number of metrical feet per line of poetry);

- measurement devices (devices to measure length, height, width, pressure, etc.);

- units of measurement in the metric system.

I'd dispose of the first category cavalierly by saying that *everybody* knows that in such words the stress always falls on the syllable in front of the "-meter." For example,

anapestic *di*meter
trochaic *tri*meter
dactylic hex*am*eter

I might even mention, in passing, that I'm still looking for a person who *must* exist -- a person named Bickford Pentameter. When he is finally pointed out to me, I'm going to go right up to him and say, "You look just like Bick Pentameter!" and wait for him to reply, "I *am* Bick Pentameter!"

Then, swinging back to the main argument, I'd say that words ending in "-meter" and designating *devices* also have the stress in front of the "-meter." I'd give examples like:

ba*rom*eter
ther*mom*eter
spee*dom*eter
sphygomoman*om*eter
al*tim*eter
*vol*tmeter
alcoho*lom*eter, alcoho*lim*eter (also *al*coholmeter)

Then I'd say, "Plus innumerable other ones," meaning that I couldn't think of any more. I might, to be intellectually honest, mention as a sort of exception:

drun*kom*eter, *drunk*ometer

but I'd weasel out of that by asking my opponent to just imagine a sheriff in a speedtrap town saying, "Wal, we'll jes' see what our li'l ole drun*kom*eter says about that." Nope, it just don't sound right.

Finally, getting closer to the end of my oh-so-logical argument, I'd say, "But words designating *units of measurement* in the metric system have a primary stress on the first component and a secondary stress on the "-meter." Like:

*cen*timeter	*mil*limeter
*dec*imeter	*mic*rometer

And when I got to *mic*rometer, I'd say, "Gotcha!"

Because, as a unit of measurement (equal to one millionth part of a meter), it's pronounced mi*cro*meter, but as a gadget for measuring small tolerances, it's a different word, micr*o*meter!

With my opponent hanging on the ropes, I'd use the ultimate weapon -- sarcasm. I'd say, "You don't *really* mean to tell me that you're using that laissez-faire Webster's *Third* as an authority, do you? With its kilometer-shmilometer attitude toward pronunciation? Just look at the Webster's *Second* (three cheers for the Puritan ethic!), where the pronunciation of kilometer is shown as '*ki*lometer; sometimes ki*lo*meter by false analogy with barometer, etc.' How in the name of Holy Hannah could a person with *your* astuteness make a (snicker, snicker!) 'false analogy' between a *unit* of measurement and a *device* for measurement?"

I would then, ladies and gentlemen of the jury, sum up the argument by saying, "The only sensible pronunciation is *ki*lometer."

But language isn't logical. . .

But language isn't logical, so I think I'd say, "So what if every word beginning in 'kilo-' is stressed on the first syllable -- couldn't ki*lo*meter be an exception?" Sure it could! Who says that life doesn't have exceptions? Couldn't a certain country have 37 varieties of snakes, only one of which is poisonous? Could a person have four brothers, only one of whom has red hair? So why couldn't ki*lo*meter be an exception -- the only word with "kilo-" accented on the *o*? Sure it could!

And so, if you think it sounds "nicer," "more correct," "more European," or just plain like the sound of it because there's a word ki*lo*metro in Spanish, go right ahead and pronounce it ki*lo*meter. I really don't mind. Say it! Ki*lo*meter, ki*lo*meter, ki*lo*meter -- see, I'm not flinching! But although I say it's okay for you to say it your way, please don't try to make me say it your way too.

Back to the neutral corners. . .

I know it's going to be hard for you to accept my sanctimonious understanding of your aberration (cf. *Games People Play*), so why don't we declare a moratorium on the word? Why don't we use a word that every American ever stationed in Germany uses, a word that probably has already, like the expression "No sweat!", entered the German language too. It's the word "click." No American in Germany says, "It's 60 kilometers to Stuttgart." It's always "60 clicks" or "60 K's." Instead of saying ki*lo*meters and looking at me funny when I say ki*lo*meters, why don't you just use the word "click"? Think how good you'll feel, using a word correctly even before it's listed in the dictionary! And how stunned you'll be, years from now, when you read in Webster's *Fourth*: "Click; also, by false analogy with kilometer, klick. . ."

(UNCLASSIFIED)

LETTERS

To the Editor, CRYPTOLOG:

In your March 1977 issue you published a letter by Dan Buckley which demonstrated several common misconceptions concerning linguists working at NSA and one misconception in particular -- that linguists simply turn "foreign sounds or words into English sounds or words." Mr. Buckley feels that a "single-language linguist" hardly deserves to be promoted into the supergrades for performing such a simple task. He conveniently places all "highly skilled single-language linguists" into one group and assumes that they all do the same job. He labels them "desk linguists," which reinforces the idea that they are something less than a "real linguist." I cannot speak for all the linguists in the Agency, but I do know that the linguists in A64 should be highly insulted by Mr. Buckley's ignorance concerning the work that the "desk linguist" does for the Agency.

We in A64 are charged with the daily task of, as Mr. Buckley so generously puts it, "turning foreign sounds or words into English sounds or words," a skill so simple that we are going to be replaced by high-school graduates at grade level 2, in Mr. Buckley's opinion. This seems quite silly, considering that most individuals in A64 have at least the equivalent of 4 or more years of formal language education. This often includes a general literary knowledge as well as a special technical knowledge in a particular language. But even this is not enough to step into a "desk linguist's" job in A64. Sometimes it takes as much as 2 years' experience before a "desk linguist" is doing a halfway competent job of turning "foreign sounds or words into English sounds or words."

Mr. Buckley wrote his letter to criticize an article (written by ⬛⬛⬛⬛⬛ and published in the December 1976 CRYPTOLOG) which advocates promotions into the supergrades for linguists. Mr. Butcher was quite specific on why the linguist deserves promotions into the higher grades. However, Mr. Buckley appears to have missed the point, so perhaps I can clarify the situation for him.

Besides having a mastery of the language, the "desk linguist" in A64 often requires a special

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and detailed knowledge of a specific target area -- knowledge that is not easily acquired and that can be very technical.

Thus this simple task is not quite as simple as Mr. Buckley would have us believe. It requires a variety of skills, including a great deal of experience. I would venture to say, although there is no way to prove it, that an NSA linguist's job is never as easy as "turning foreign sounds or words into English sounds or words."

But Mr. Buckley will not admit this, and would rather lose these hard-earned skills than promote linguists beyond grade 12 . Unfortunately, it also appears that Agency management agrees with him. Thus, linguists flee to other disciplines in hope of promotions and other rewards, and this results in a significant loss of manpower and skills. Then the Agency scurries to hire more linguists, wondering why it's impossible to keep up with the drain. This method of operation has its costs. Recruiting, hiring, and training new linguists is not cheap. But it seems that the Agency prefers to put money into recruiting new linguists, rather than using that same money to keep experienced ones on the job.

It is also interesting to note that the Agency not only limits the promotions and financial rewards for a linguist but also severely restricts the recognition the "desk linguist" in A64 gets for the work he does. Often his work is highly diluted in the final report. Even the work he sends to the analysts will contain only his initials and the analysts

may never bother to recognize the contribution. The linguist may put days of work into turning those foreign sounds or words into English sounds or words and then they may not even be recognizable in the final product, if the linguist ever gets the opportunity to see the final product.

Putting all Agency linguists into one pot is hardly fair. But to insinuate that all a linguist does is "turn foreign sounds or words into English sounds or words" is downright inaccurate. The language problem is seldom that simple and linguists should be paid for their special knowledge and skills, even into the supergrades if that is what it takes to keep them on the job. Furthermore, linguists should fill Mr. Buckley's mailbox with reasons why they should be promoted beyond grade level 12. Perhaps he will come to realize that sinking money into recruiting, hiring, training, and waiting for linguists to gain experience is more expensive than making it worthwhile for experienced people to stay at their jobs -- jobs that are not easily refilled. And that *is* the truth, Mr. Buckley!

(CONFIDENTIAL)

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To the Editor, CRYPTOLOG:

[   ] article on the Russian PQE (CRYPTOLOG, April 1977) was timely, informative, and thought-provoking for all of NSA's Russian linguists. It is to be hoped that those in a position to effect changes will seriously consider those defects which [   ] article pointed out. Certainly it is to the Agency's advantage to revise and update any test of the importance of the PQE in order to make it fairer to all.

I would, however, like to correct a mistaken impression which [   ] obviously received from the NCSch course catalog: RS 220 (Intermediate Russian Transcription) has not been given since 1971, and the NCSch has no plans to conduct such a course in the future. One might well ask, why is it listed in the current course catalog? As a result, this means that there not only is no course to prepare a linguist for Part IIa (classified translation), but there is also no course with which one can prepare for Part IIB (classified transcription). It would be most interesting and enlightening to hear from someone in a responsible position as to why this is the case and what can be done about it.
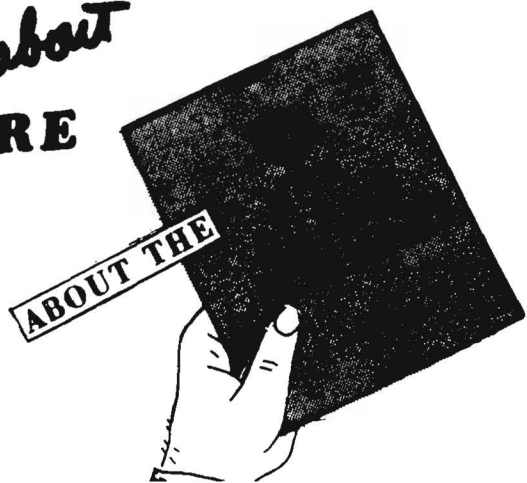
(CONFIDENTIAL)

more about
MORE
∧

ABOUT THE

The author of the following letter began it by rewriting the first paragraph and some of the second paragraph of an article that appeared in the March 1977 CRYPTOLOG.
Ed.

To the Editor, CRYPTOLOG:

The ~~May 1976~~ *March 1977* issue of CRYPTOLOG contained an article by ~~[redacted]~~ ~~GA/PPP~~, which de-scribed in some detail the ~~functions and pur-poses of the NSA SIGINT Summary. On the whole it was rather complete and quite interesting.~~ ~~But for the~~ period between the inception of the SIGSUM and ~~Bill's~~ *Bill Hunt's* association with it ~~But for the~~

period between the inception of a consolidated NSA current reporting vehicle and Paul's knowledge of the SIGSUM — a

period of ~~6 or 10~~ *several* years -- the article provided ~~virtually~~ no information at all. Having, with some others, devoted a part of those years to the business of ~~conceiving and~~ developing the *;s ancestor;* SIGSUM, I am perhaps in as good a position as
∧

(except the selfsame Bill Hunt)
any to fill in the gaps. In ~~the process, I will~~
∧ *leaving such a gap,*
~~also clarify some statements in~~ the article *was* ~~that are~~ unintentionally misleading, made so *Paul* simply by the fact that ~~Bill~~ had no part in the *original* conception and early development of the report
∧

and therefore could not be expected to know how it all began.

In the early *1950's* ~~1960's~~, a number of events occurred which, taken together, had a far-reach-ing impact on the role NSA was then playing in the ~~U.S.~~ intelligence community. ↖

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P.L. 86-36
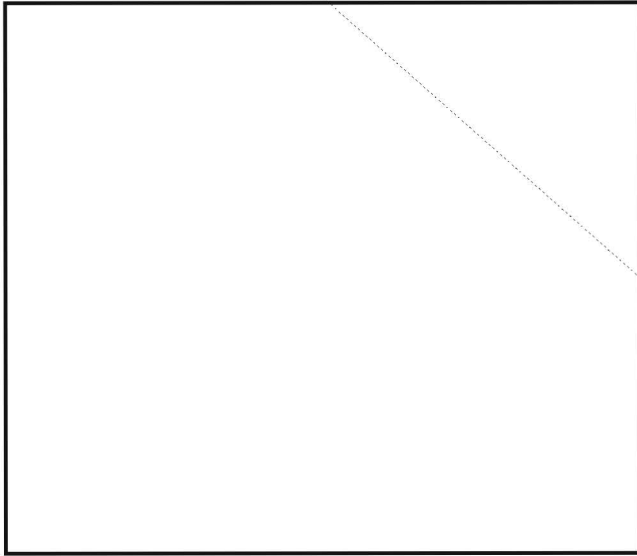
missing. The station located on the southern tip of Greeland was called "GAMMATRON" and I am quite positive that the designator was "G" and the call was NTG.

Also missing on the list was U.S. naval radio station Poyners Hill, N.C., which was located about 20 miles north of Nag's Head on the Outer Banks. Its designator was "P," as Mr. McGrillies indicated and the callsign eludes me for the moment. Poyners Hill was turned over to the Coast Guard just after VE Day in 1945 and has totally vanished except for foundations of buildings.

A reunion of former members who were stationed at Poyners Hill was held in September 1976. Only seven members were located for the reunion but we are planning to hold another if we can get additional names and addresses of former personnel. Anyone having served at Poyners Hill, or knowing the whereabouts of anyone who served there, please call me on 796-6528.

P.L. 86-36

(CONFIDENTIAL)

Melville J. Boucher, V1

(CONFIDENTIAL CCO)

To the Editor, CRYPTOLOG:

In the list of U.S. naval radio stations during World War II, a couple of stations were

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AN ENTERTAINING EXCURSION with Charles Lacombe
at the 1977 CLA Banquet..."Does Anyone Here Speak Ancient Mayan?"

The date ⚏⚏⚏⚏⚏ * is drawing near!

That's the date of the CLA's Annual Banquet at: Sheraton-Silver Spring Motor Inn, Colesville Road, Silver Spring, Md.

Cash Bar - 6:30 p.m.
Dinner - 7:30 p.m.

Dinner is a lavish buffet (roast beef, chicken, etc.), with salad and dessert courses served at the table.

Price, $9.00 per person.

Reservation deadline, Friday, 17 June 77.

* Remember? "12.18.3.17.16 - 13 Men 13 Zotz," in our calendar, comes out to Thursday, **23 June 1977**

For reservations, call any of the following:
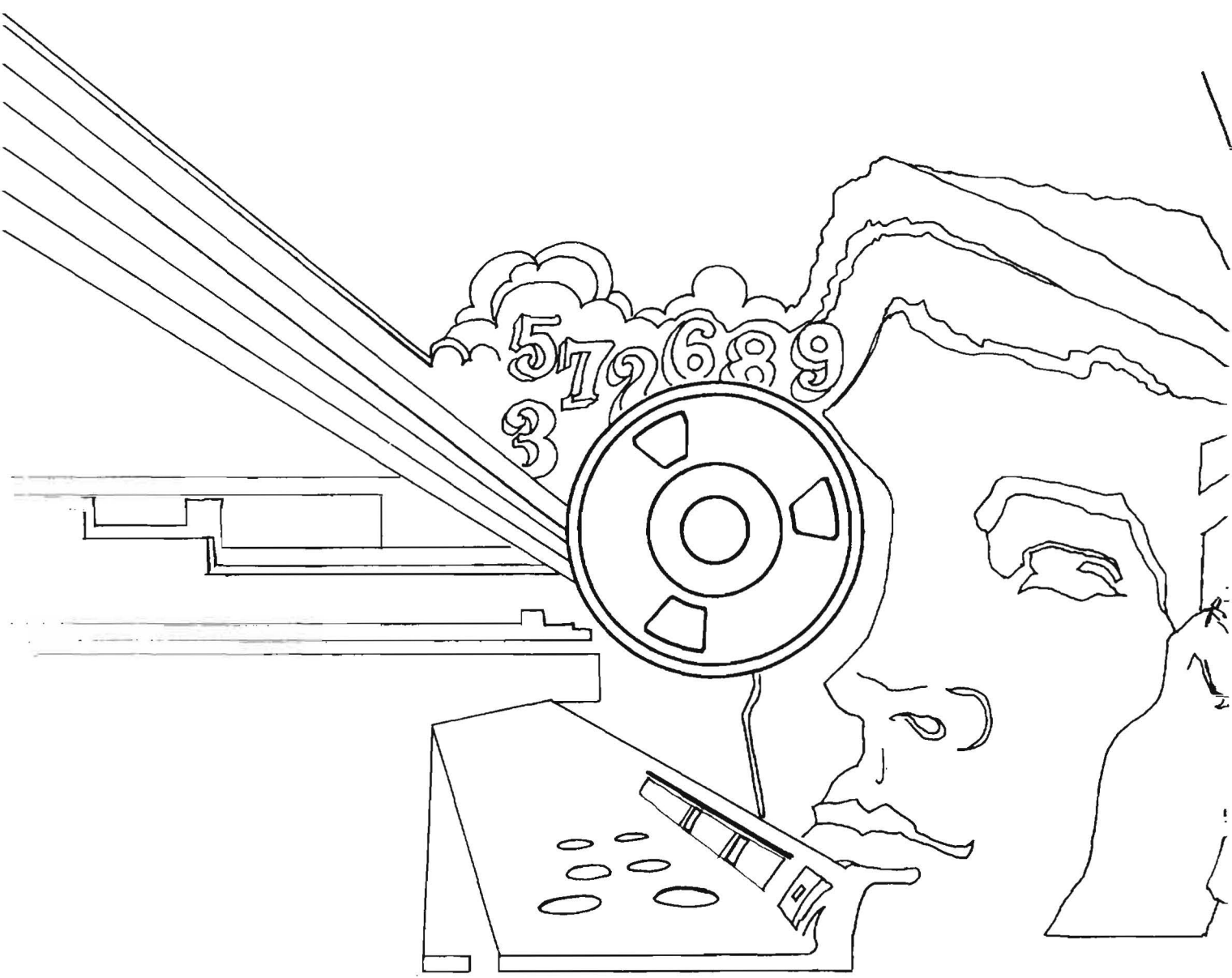Steve Bladey (Chairman)...5236s
Rose Baruzzi.............4477s

P.L. 86-36

..8404s
..4966s
..4751s

(UNCLASSIFIED)